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# Tools That Work



When NASA needed a special hand tool for the International Space Station, they called Bondhus. They needed the very best tool for the most demanding of applications. NASA discovered what millions of professional tool users around the world already know - Bondhus tools work in even the most difficult circumstances.

PHOTO COURTESY OF NASA JOHNSON SPACE CENTER



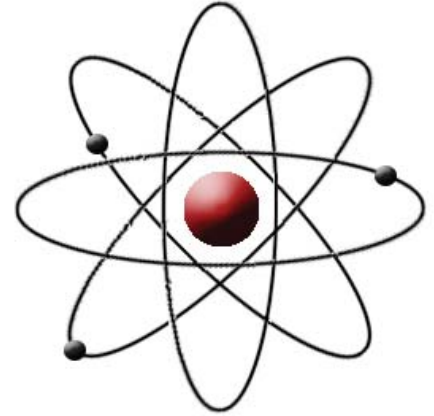
## A message from the Employees of Bondhus Corporation

Prior to founding Bondhus Corporation in 1967, John Bondhus worked for many years as a tool and die maker. He always took great pride in "working in the shop". He understood and appreciated the value of high quality, long lasting, time-saving tools. He was appalled by low quality tools. He vowed his company would never compromise usability or quality, in exchange for lower manufacturing costs or gimmicky design features. He founded and nurtured Bondhus Corporation to make the highest quality hand tools in the world. We are honored to carry on the Bondhus tradition of making and supplying the best tools in the world, tools that are:

**Built to Work Hard...Built to Save Time...Built To Last!**

# Protanium® High Torque Steel

Protanium® Steel is much more than “just steel” and much more than a “name”. It is a commitment to producing a level of tool performance unmatched by any competitor. Protanium® High Torque Steel is not an 8650 grade of steel, it is not a form of S-2 and it is not a chrome-vanadium or chrome-moly type of steel. Protanium® High Torque Steel is custom mixed to a formula that is the result of many years of research and continuous development efforts. Bondhus’ customized heat treating processes are the key to bringing out the superior strength properties of Protanium® High Torque Steel. Attaining results that push beyond the accepted limits of performance requires the skill and years of research and development that Bondhus alone has committed itself to.



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## Features

- 1) Protanium® High Torque Steel - a custom blended steel
- 2) Bondhus controlled steel drawing process
- 3) Customized heat treating process ensures optimal combination of hardness and ductility
- 4) Lifetime warranty

## Benefits

- 1) Protanium® Steel tools are up to 20% stronger than competitor tools made from standard grades of steel.
- 2) Smooth surfaces, sharp corners and extremely tight tolerances ensure that Bondhus tools last longer.
- 3) Bondhus tools are harder and more ductile than competitor's tools. They wear longer, generate greater torque and resist breakage and shattering.
- 4) Bondhus stands behind every sale with a “No questions asked” lifetime replacement policy

\* Bondhus, Bondhex, ProGuard, Protanium, Balldriver, BallStar, GorillaGrip, BriteGuard and GoldGuard are trademarks of Bondhus Corporation.

# Protanium® High Torque Steel

## 1) Protanium® High Torque Steel - a custom blended steel

### Custom blended steel versus common grades of steel

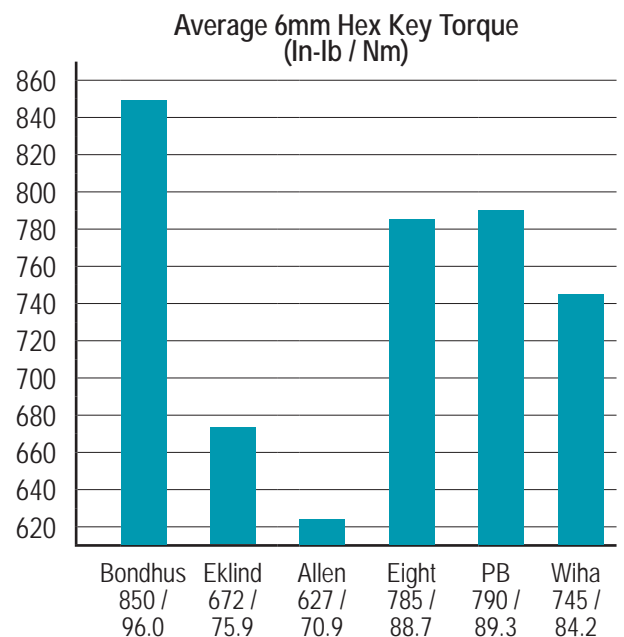
In the broadest possible terms, only two categories of steel are used in the manufacturing of hex and Star tools; custom blended steel and standard grades of steel. A simple comparison makes it easy to see why Bondhus custom blended Protanium® Steel achieves far greater levels of performance than standard grades of steel:



Custom blended Protanium® Steel	Standard grades of steel
A custom blend specifically designed for the rigors and requirements of hex and Star tools	Standard grades of steel are a one-size-fits-all solution, designed for a range of uses, not just hex and Star tools
The elements making up the steel's composition and the process used to produce the steel are customized to the Protanium® Steel specification, enabling use of customized heat treating processes that produce tools with greater hardness and ductility	The tool manufacturer has no control over the steel's blend. Heat treating cannot be customized beyond the limitations of the standard blend
Imperfections are eliminated through the addition of specific elements and by controlling the methods by which mills produce the steel	Tool manufacturer has no control over the steel's production or imperfections that may result
Meticulous quality control, monitoring and documentation are enforced by the Protanium® Steel specification	Steel mills perform their own "standard" quality control
The drawing process is controlled to produce stock with highly precise dimensional accuracy, sharp corners and smooth clean surfaces	Tool manufacturer has little control over drawing process

Except for Bondhus, all other hex and Star tool manufacturers use various standard grades of steel in the manufacturing of their tools:

- 8650 is the most common grade in use throughout the U.S. and Asia. It does not achieve the hardness or ductility levels of Protanium® steel.
- Chrome Vanadium is comparable in performance to 8650. It is used primarily in Europe.
- Chrome Moly is similar to Chrome Vanadium, but is somewhat stronger and harder. Because it is fairly expensive, manufacturers generally only use it on their higher priced tools like ball end products, and substitute lower grades for their hex and folding tools. Europe and Japan are the primary users.
- S2 is used by only a small number of manufacturers. It is harder than 8650, but it is also less ductile, more costly, and far more prone to shattering.
- Carbon steel grades, such as 1050, are low-grade steels that are inferior to those listed above. They are still used by some manufacturers in Europe and Asia.



# Protanium® High Torque Steel

## Custom blended Protanium® Steel

The current Protanium® Steel formula is the result of many years of research and ongoing improvement. Protanium® Steel is a custom blend developed by, and only available from, Bondhus. It is not 8650 or any other common grade of steel. It is a specification and a process for the manufacturing of extremely high quality, high torque steel, tailored specifically to the unique requirements of hex and Star tools. Every aspect of its production, from mill to finished tools, is subject to the Protanium® Steel specification and rigorous quality assurance testing.

Tools made from custom blended Protanium® Steel offer a level of performance that tools from common grades of steel simply cannot match. Protanium® Steel is the cornerstone for every tool manufactured by Bondhus.

**High performance tools** from Bondhus attain a level of quality and performance unmatched by any competitor and unattainable from standard grades of steel. Independent lab testing has proven that Protanium® Steel tools consistently generate up to 20% more torque than competitor tools.

**The controlled drawing process** for Protanium® Steel yields stock with highly precise and consistent dimensions and smoother surfaces with sharp clean corners. Stripping of tools and screw heads is reduced or eliminated and tools made from Protanium® Steel provide up to twice the wear resistance of standard grades of steel.

**Customized heat treating** of Protanium® Steel produces tools with greater hardness and ductility than competitor tools. Protanium® Steel tools generate greater torque and are highly resistant to breakage and shattering. Precise control over the heat treating process means Bondhus tools are of uniform high quality for every tool in every size Bondhus manufactures.

## Degassing - tougher tools

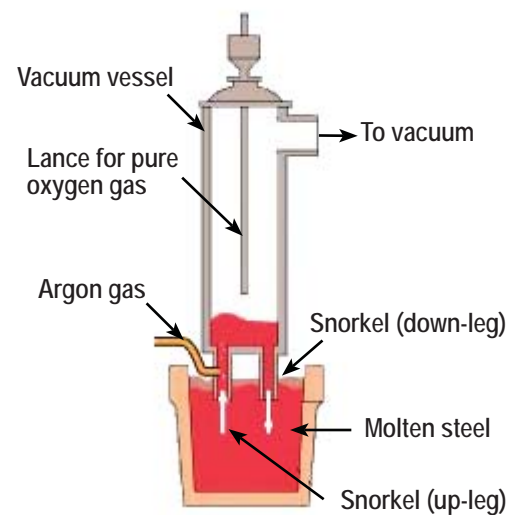
Gases such as hydrogen and nitrogen are naturally present in molten steel, and as cooling takes place, they can form pockets within the steel and compromise its integrity. Traditionally, steel has been cooled slowly to reduce the effects of the problem. This approach is not the best solution.

The Protanium® Steel specification calls for vacuum degassing or argon bubbling for effective removal of hydrogen and other gases from the steel. The process also removes harmful alumina and produces very clean, high quality steel.



Even 1/4" steel could not stop this Bondhus tool

RH type degassing unit (RH)



# Protanium® High Torque Steel

## Defects are eliminated in Protanium® Steel

The production of steel introduces a common category of defects that compromise the integrity of high quality steel. It is important these defects be eliminated, especially in high stress applications such as hex tools. Because hex and Star tools are continuously subjected to high levels of torque, fatigue will cause crack growth in the area of these defects, and incidents of breakage and shattering will increase.

The Protanium® Steel specification requires monitoring of steel to identify and eliminate defects that can contribute to breakage and shattering.

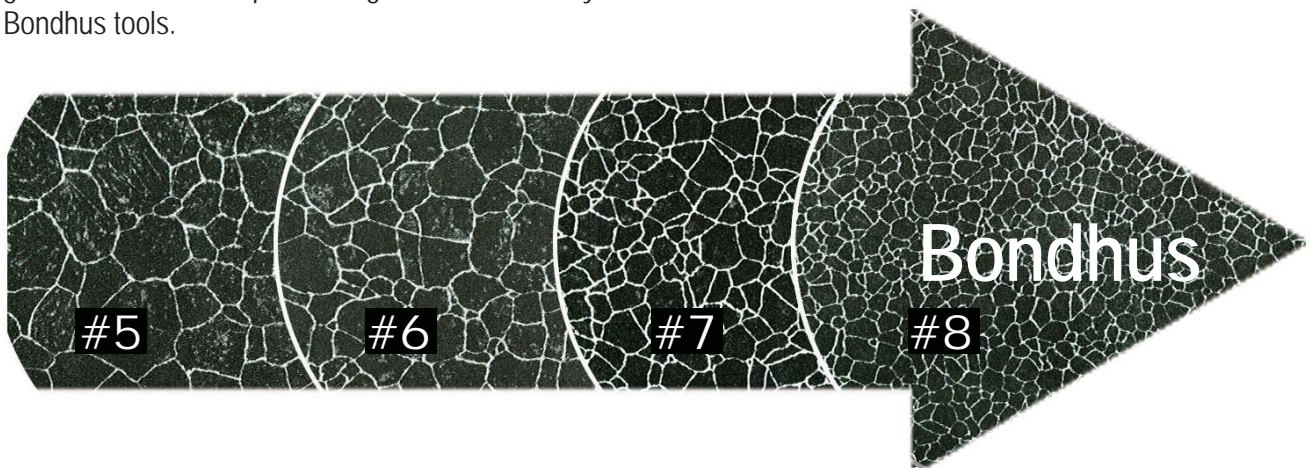
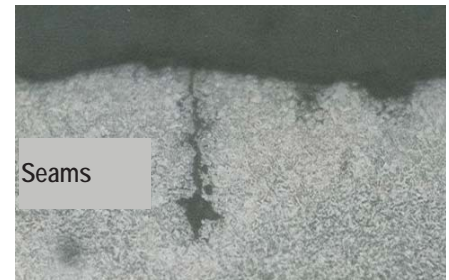
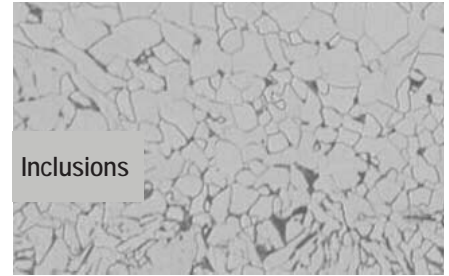
**Inclusions:** Oxide inclusions occur in the alloying of steel as a result of the elements that are added to the liquid steel. Additional elements are added to the Protanium® Steel mixture to virtually eliminate this problem.

**Seams:** When steel is drawn through a die, it can separate and then rejoin at the exit point of the die to form defects known as seams.

**Surface discontinuities:** Irregularities, imperfections, or cracks found on the surface of the steel. Even defects so small as to be undetectable in visual inspection can cause serious problems.

**Large grain size:** Grain size is constantly monitored in the production of Protanium® Steel, because the smaller the grain size, the tougher and more ductile the steel. Competitor hex and Star tools typically have a grain size of #5, and occasionally smaller.

The Protanium® Steel specification requires an average grain size no larger than #8. Elements added to the Protanium® Steel blend assist in producing smaller grain size, and customized heat treating maintains this small grain size to assure optimal toughness and ductility of all Bondhus tools.



#5  
12 to 25 grains  
per sq in

#6  
24 to 48 grains  
per sq in

#7  
48 to 96 grains  
per sq in

#8  
96 and greater  
per sq in

Smaller grain size creates tougher, more ductile tools

# Protanium® High Torque Steel

## 2) Bondhus controlled steel drawing process

Changing the size or shape of a metal bar or rod by pulling it through a die is known as drawing. It is a critical process in the production of high quality steel, since it determines the dimensional precision and surface quality of the steel.

Standard grades of steel are drawn to tolerances that do not conform to the Protanium® Steel specification for precision, so Bondhus exercises full control over the drawing process. Bondhus works closely with its' steel suppliers to ensure 100% compliance with the Protanium® Steel drawing specification, and will not work with any mill unwilling to make this commitment.

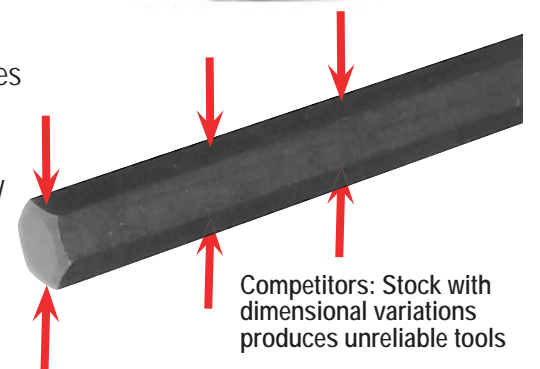
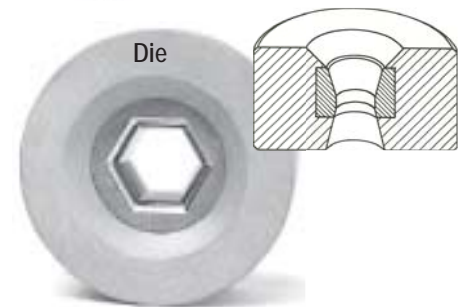
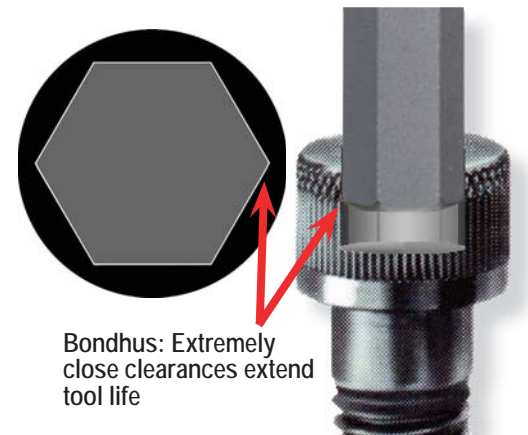
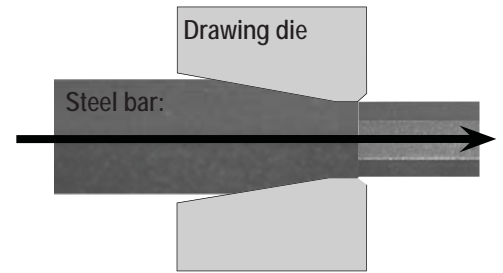
### Close clearances

Tolerances imposed by the Protanium® Steel drawing specification produce stock so precisely drawn that clearances between a Bondhus tool tip and the screw walls is typically one half thousandth of an inch or less. Clearances this close produce tool tips with greater surface area contacting the screw walls. Smaller clearances between the tool surface and the screw head mean Bondhus tools greatly reduce wear of tool tips and and screw heads, and reduce or eliminate the potential of stripping.

**Dimensional accuracy** Bondhus quality assurance processes closely monitor the dimensional accuracy of Protanium® Steel stock. Dimensions across flats and across corners are required, without exception, to be within specification. This is another primary reason why Bondhus tools are so consistently reliable.

Bondhus requires that only high quality dies and state-of-the-art processes be used for the drawing of Protanium® Steel. Like all mechanical devices, after a period of use a die begins to wear. Consistency and tolerances are compromised, and various types of surface imperfections begin to appear. The Protanium® Steel quality assurance process requires all steel shipments to be tested for any out-of-specification conditions before they leave the mill. If any single one is present, Bondhus will flatly refuse the shipment.

Competitor tools drawn to looser tolerances can produce stock that varies greatly in dimensional accuracy, even across the length of a single bar. The result is tool tips with the potential for wide dimensional variations and inconsistent tool performance. Tools that are inconsistent are simply unreliable.



# Protanium® High Torque Steel

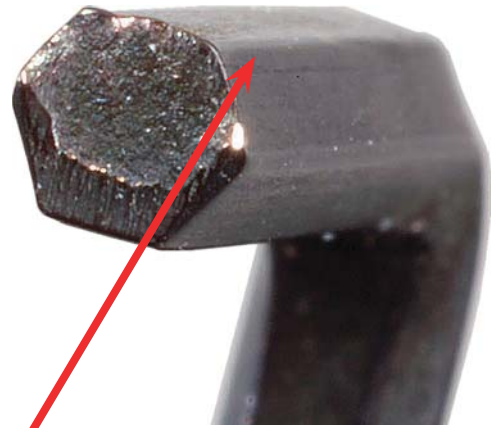
## Sharp corners

Another requirement of the Protanium® Steel drawing specification is that corners be sharp and smooth. Eliminating gaps between the tool tip corners and the screw walls means tool tip surface area increases. Tool tip and screw head wear is greatly reduced, since the primary cause of screw stripping has been eliminated.



Bondhus: Sharp, clean corners

Standard grades of steel allow far more rounding of corners during the drawing process and surfaces that are not nearly as smooth, so the process of tool wear and screw stripping is accelerated. Once again, tools made with standard grades of steel perform inconsistently and unreliably.



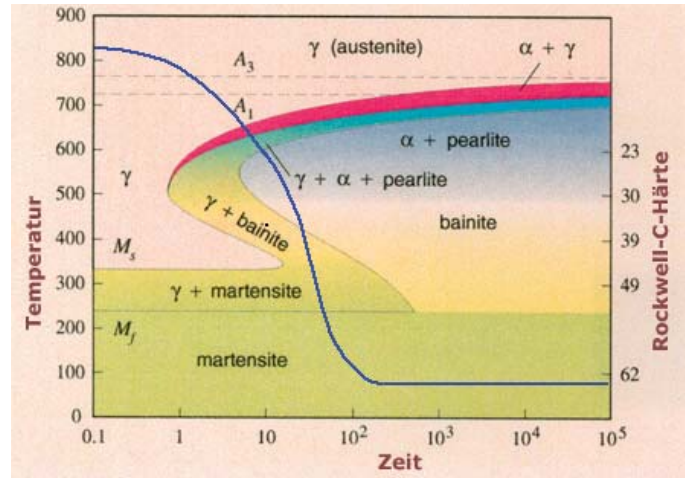
Competitors: Rounded corners accelerate wear and stripping



# Protanium® High Torque Steel

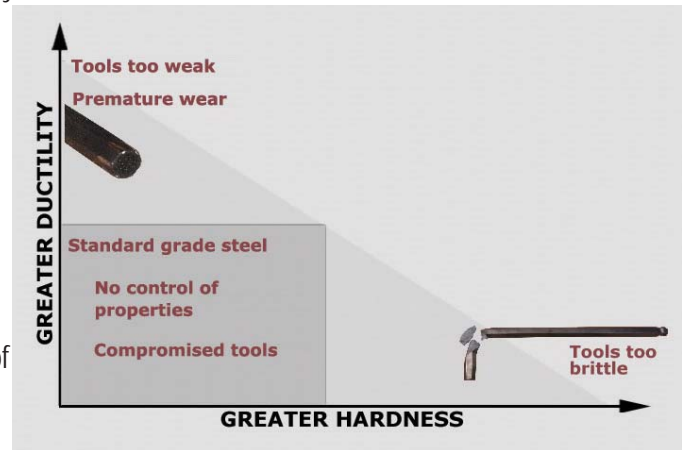
## 3) Customized heat treating process assures optimal combination of hardness and ductility

Heat treating is a series of processes where steel is heated to a temperature referred to as its *transformation point*, where its atomic structure actually changes. It is then cooled (quenched) in a highly controlled process where it is held at a specific *temperature* for a precise period of *time*. Complex documents known as TTT Charts (Time / Temperature / Transform) show this relationship. They assist in determining an optimal heating and quenching cycle for obtaining desired properties such as optimal microstructure, grain size, hardness and ductility.



Sample TTT chart

A professional grade hex or Star tool needs to be extremely hard, but it must also retain ductility. The difficulty in attaining the optimal combination of hardness and ductility is that as hardness is increased, ductility decreases. Tools lacking ductility can become brittle, and shatter when torque is applied. A tool user can be seriously injured, and undetected steel fragments can do damage by lodging in delicate equipment. Decreasing hardness increases ductility, but the loss of hardness means tools are weakened as a result. A weak tool will not generate maximum torque and will wear prematurely. Every grade of steel has an upper limit, beyond which brittleness or weak tools will result.



## Truly customized heat treating

An essential point to understand about heat treating is that the blend of the steel largely determines how and to what extent desired properties of the steel can be obtained in the heat treating process. In other words, controlling and customizing the blend of the steel is the only means by which truly customized heat treating can be accomplished. Protanium® Steel starts as a custom blended steel, and is transformed into hard, ductile tools by customized heat treat processes.

- Competitors must perform their heat treating to accommodate the limitations of the standard grades of steel they purchase. Since they have no control over the blend of the steel, their heat treating cannot achieve the levels of hardness and ductility achieved by Protanium® Steel.
- Bondhus continually improves the blend of Protanium® Steel to achieve full customization of the heat treating process. With full control of the steel's blend and its heat treating, Protanium® Steel is capable of achieving levels of hardness and ductility well beyond the limitations of the standard grades of steel used by competitors.



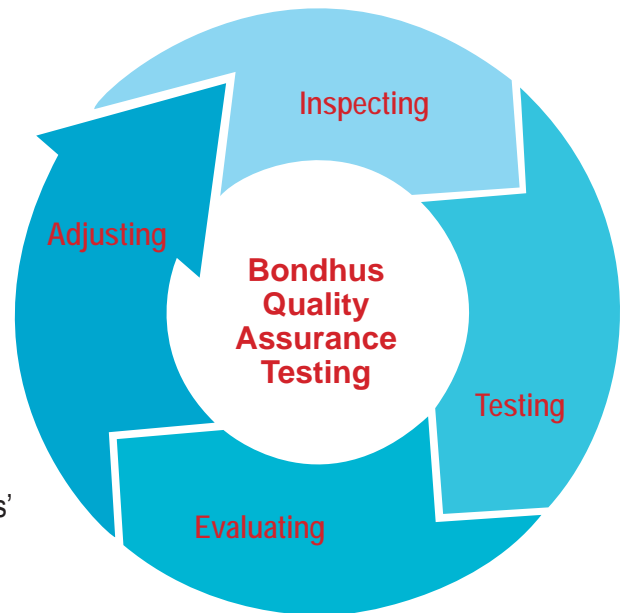
# Protanium® High Torque Steel

## In-house heat treating

Heat treating is a very critical step in the production of professional grade Bondhus tools, so Bondhus never relies on the results of outsourcing the task. Bondhus performs all heat treating internally, with highly qualified personnel who are specially trained in the discipline of heat treating to the Protanium® Steel specification. Every individual possesses many years of specialized heat treat experience.

## Quality assurance

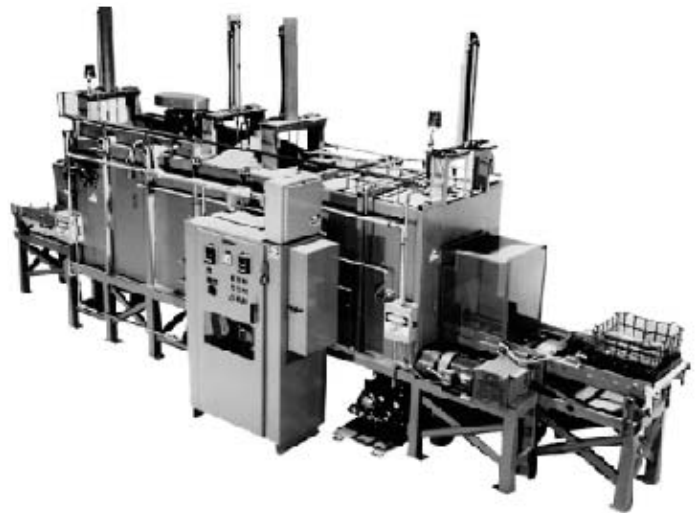
Quality assurance testing is integral to the manufacturing of Bondhus tools and is always performed by fully qualified Bondhus technicians. In total, over 60 individual tests are performed throughout the production process to absolutely guarantee 100% compliance to the Protanium® Steel specification for quality. The Bondhus policy of 'no compromises' is enforced by an endless cycle of inspecting → testing → evaluating → adjusting, and starting the cycle over again.



**Consistent heat treating results:** It is essential the heat treating process produces uniform hardness, ductility, microstructure and grain size for every tool being heat treated. To do so, the distribution of heat within the furnace must be extremely uniform. Hot and cold spots produce tools with inconsistent properties and inconsistent quality. Bondhus uses custom built, controlled atmosphere furnaces to control and monitor temperature and heat distribution within the furnace. The result is tools with uniform hardness, ductility and essential properties, regardless of their location within the furnace. This is another factor that contributes to the 100% consistency of quality in all Bondhus tools.

## Ongoing improvement

The Protanium® Steel specification is not a static formula. Unlike standard grades of steel, a key feature of custom blended Protanium® Steel is the ability to adjust its mixture. Precise quantities of certain elements are added to enhance the "hardenability" and ductility of the steel. In other words, the desired hardness and ductility can be maximized through the ideal combination of the steel's mixture and a heat treating process tailored to the specific mixture. Bondhus continually makes improvements to the Protanium® Steel blend.



Bondhus custom made controlled atmosphere furnace for even heat and consistent results

## Hardness testing

Hardness can be accurately tested with the aid of a device such as a Rockwell hardness tester. The tester uses a diamond tipped indenter that is forced against the surface of the steel at a known pressure to create small indentations. The depth of the indentations can be measured and used to calculate an exact hardness value.

# Protanium® High Torque Steel

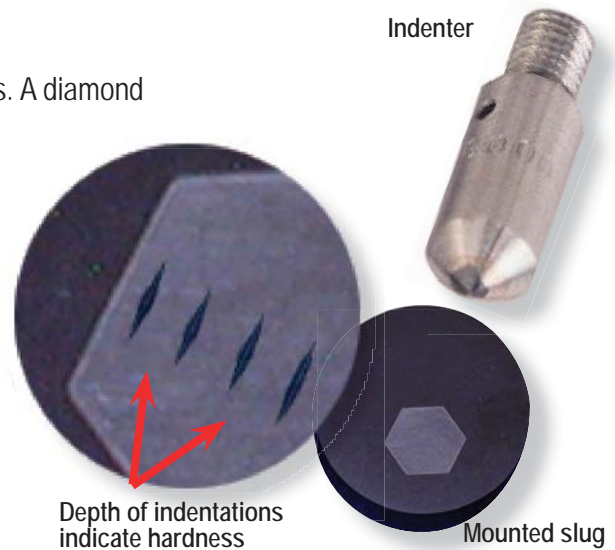
Bondhus monitors hardness to assure that tools heat treated from Protanium® Steel are neither too hard (causing brittleness) nor too soft (causing weak tools). Another important function of hardness testing is to assure consistency of hardness within each heat treated batch, regardless of where the tool was located within the furnace. These tests help guarantee every Bondhus tool will perform to the high standards demanded by the Protanium® Steel specification.

## Depth of hardness

It is important the surface of a tool be hard, in order for it to provide good wear. Just as important, hardness must extend through the entire tool. Bondhus tools achieve higher levels of hardness (while preserving ductility) than any other competitor. That hardness also extends to the core of the tool to provide exceptionally high levels of torque capability.

Again, Bondhus closely monitors hardness throughout the tool. Values are checked both before and after heat treating using cut and polished cross sections of steel. These slugs, as they are referred to, are encased in epoxy, ground to a mirror finish and etched to bring out their grain structure when viewed under a microscope.

Once slugs have been prepared, they are tested for hardness. A diamond indenter makes diamond shaped pyramid impressions at regular intervals across the diameter of each steel specimen. The length and depth of the impressions is then used in the calculation of hardness.



Hardness testing

## Ductility testing

As hardness increases, it is important to monitor ductility to prevent the potential for brittleness and shattering. Bondhus monitors ductility by breaking tools from each heat treat load and monitoring both the torque generated and the break condition. The Protanium® Steel specification requires more than 99% of all breaks to be straight and clean. Most competitor tools cannot even hit 50%. Tools that shatter endanger both the tool user and sensitive equipment.



Competitors: Stock with dimensional and heat treat variations produce unreliable tools

# Protanium® High Torque Steel

## Tensile strength

Even tools with superior hardness and ductility will break when torqued/ twisted far enough beyond their capacity. Tensile strength is the resistance of a material to being torn apart. Protanium® Steel is tested for tensile strength by applying an increasing level of torque to a sampling of parts from each heat treat batch until failure occurs. If even a single piece fails to meet the minimum torque levels required by the Protanium® Steel specification, the entire batch is rejected.

Approximate tensile strength can be found by consulting standard hardness charts such as the one to the right. The average hardness for a small Bondhus tool is approximately 59 RC. However, note there is no tensile strength even listed for hardness values over 55 RC. That is because publishers assume that levels of 59 RC will realistically not be reached; true testimony that Protanium® Steel is in a unique class of its own when it comes to hardness and tensile strength.

Note: For a comparison of Bondhus hardness and torque capacity to competitors, see chart on next page.

C	A	BHN	15-N	30-N	VICKERS	HARDNESS	TENSILE STRENGTH
150 KG DIA-MOND	60 KG DIA-MOND	3000 KG 10mm BALL	15 KG N DIA-MOND	30 KG N DIA-MOND			
ROCKWELL	ROCKWELL	BRINELL* (carbide ball)	ROCKWELL Superficial	ROCKWELL Superficial	Diamond Pyramid		Thousand lbs. per sq. in.
68	85.6	...	93.2	84.4	940		
67	85.0	...	92.9	83.6	900		
66	84.5	...	92.5	82.8	865		
65	83.9	739	92.2	81.9	832		
64	83.4	722	91.8	81.1	800		
63	82.8	705	91.4	80.1	772		
62	82.3	688	91.1	79.3	746		
61	81.8	670	90.7	78.4	720		
60	81.2	654	90.2	77.5	697		
59	80.7	634	89.8	76.6	674		
58	80.1	615	89.3	75.7	653		
57	79.6	595	88.9	74.8	633		
56	79.0	577	88.3	73.9	613		
55	78.5	560	87.9	73.0	595		301'
54	78.0	543	87.4	72.0	577		291
53	77.4	525	86.9	71.2	560		283
52	76.8	512	86.4	70.2	544		273
51	76.3	496	85.9	69.4	528		264
50	75.9	481	85.5	68.5	513		256
49	75.2	469	85.0	67.6	498		246
48	74.7	455	84.5	66.7	484		237
47	74.1	443	83.9	65.8	471		231
46	73.6	432	83.5	64.8	458		221
45	73.1	421	83.0	64.0	446		215
44	72.5	409	82.5	63.1	434		208
43	72.0	400	82.0	62.2	423		201
42	71.5	390	81.5	61.3	412		194
41	70.9	381	80.9	60.4	402		188



# Protanium® High Torque Steel

## Torque capacity

Hardness and tensile strength are important factors impacting the wear and strength of a tool, and *torque capacity* determines a tool's ability to generate enough torque to seat and break loose screws.

Once the hardness of a Bondhus tool has been determined, the approximate tensile strength can easily be referenced in a chart similar to the one below. Combined with the stock dimension across its flats, a simple formula will determine torque capacity:

$$\text{Torque} = (\text{tensile strength}) * .2 * (0.25)^3$$

**Example:** A hex key has a hardness of 57 RC, a tensile strength of 320000 psi, and a stock size of 0.25 inches across its flats.

$$\begin{aligned} \text{Torque} &= (320000) * .2 * (0.25)^3 \\ &= (320000) * .2 * (0.1525) \\ &= (320000) * (0.003125) \\ \text{Torque} &= 1000 \text{ in-lb} \end{aligned}$$

The chart below shows the relationship of hardness and tensile strength to resulting torque capacity.

**Hardness / Tensile Strength to Torque Capacity**

Hardness Rockwell C	~ Tensile Strength psi	Torque: in-lb / NM								
		Tool size								
		5/64 - 2mm	1/8 inch	5/32 - 4mm	1/4 inch	5/16 - 8mm				
61	360000	3.8 - 34	15.9 - 141	30.8 - 273	127.1 - 1125	247.1 - 2187	Bondhus	Eklind / Allen	Asian Manufacturers	European Manufacturers
59	340000	3.6 - 32	15 - 133	29.2 - 258	120.1 - 1063	233.3 - 2065				
57	320000	3.4 - 30	14.1 - 125	27.5 - 243	113.0 - 1000	219.6 - 1944				
55	300000	3.2 - 28	13.2 - 117	25.8 - 228	106 - 938	205.9 - 1822				
53	280000	3.1 - 27	12.3 - 109	24.1 - 213	98.9 - 875	192.2 - 1701				
51	260000	2.8 - 25	11.5 - 102	22.3 - 197	91.9 - 813	178.4 - 1579				
49	240000	2.6 - 23	10.6 - 94	20.6 - 182	84.7 - 750	164.7 - 1458				
46	220000	2.4 - 21	9.7 - 86	18.9 - 167	77.7 - 688	150.9 - 1336				
43	200000	2.1 - 19	8.8 - 78	17.2 - 152	70.6 - 625	137.3 - 1215				
40	180000	1.9 - 17	7.9 - 70	15.5 - 137	63.6 - 563	123.5 - 1093				
37	160000	1.7 - 15	7.1 - 63	13.7 - 121	56.5 - 500	109.8 - 972				

# Protanium® High Torque Steel

4) **Lifetime warranty** Bondhus manufactures the highest quality hex and Star tools available, and every tool is backed by an unconditional lifetime warranty.

*"All Bondhus products are guaranteed for life. If you are not satisfied with a Bondhus tool - for any reason - simply return it. A replacement will be shipped right out at no cost - no hassles, no questions asked."*

A warranty is only as good as the company standing behind it. Bondhus has been the leading innovator in the hex and Star tool industry for over forty years.



# Protanium® High Torque Steel

## Frequently Asked Questions

### *Bondhus refers to Protanium® Steel as a “custom blended” steel. What does that mean?*

Standard grades of steel (i.e. 8650, S2, etc.) are blends that are mixed to some existing specification, available to any manufacturer who wishes to purchase them, and designed for use in a range of applications. As an example, 8650 is used to manufacture furniture frames, machine components and tools, just to name a few.

Protanium® Steel is a “custom blend” because its ingredients (blend) and every aspect of its production is defined in the proprietary Protanium® Steel specification, supplied to the mill by Bondhus. Protanium® Steel was not designed as a general use steel, but instead, to fulfill the unique requirements of hex and Star tools.

### *What makes the production of “custom blended” Protanium® Steel superior to the production of standard grades of steel?*

Hand tool manufacturers that use standard grades of steel have no control over the ingredients of the steel, the drawing process, quality assurance standards or any other aspect of its production, because they buy a standard product from their supplier.

Protanium® Steel is a custom steel. Bondhus controls the ingredients of its composition and its entire production. The Protanium® Steel specification dictates the tolerances and standards to which Protanium® Steel is melted and drawn. It also spells out the quality assurance processes that must be followed and every other aspect of its production. Common imperfections are eliminated, hardenability and ductility are improved and precision is increased. Consistency is also dramatically improved through adherence to strict manufacturing policies and quality assurance processes.

### *Is Protanium® Steel actually stronger than standard grades of steel used by competitors?*

DEFINITELY! Protanium® Steel is harder, more ductile and generates higher levels of torque than any standard grade steel used by competitors. A 6mm Bondhus tool generates at least 850 in-lb of torque, while leading competitors range from 627 - 790 in-lb. Tests done by independent laboratories prove Bondhus tools made with Protanium® Steel are stronger than competitor tools.

# Protanium® High Torque Steel



## ***Why is Protanium® Steel stronger?***

Because, the blend of Protanium® Steel is optimized to meet the extreme requirements of hex and Star tools. Specific quantities of additional elements are added to the blend to improve hardenability and ductility, reduce grain size and help eliminate defects that would otherwise compromise the integrity of the steel. Rigorous quality assurance helps guarantee conformance to the high standards of the Protanium® Steel specification. Customized heat treating, which is made possible by the custom steel blend, further improves the properties of hardness and ductility.

## ***Are all Bondhus tools made from Protanium® Steel?***

YES. Bondhus policy specifically forbids the deceptive practice of substituting lower grades of steel in product lines such as hex keys and folding tools, which is a common practice for many competitors.

## ***Why don't other tool manufacturers use Protanium® Steel?***

Protanium® Steel is the result of more than ten years of research and development by Bondhus and its' steel mill partners at considerable effort and cost. Bondhus works to constantly improve the steel mix as well as the processes used to produce the steel and the tools. Every year improvements are tested and incorporated into the Protanium® Steel specification. This ensures Bondhus tools are stronger and perform better with each successive year. Protanium® Steel is a proprietary product owned by Bondhus and is only available from Bondhus.

## ***Is there anything else tool users should know about Protanium® Steel?***

YES. It is important for tool users to realize that the high standards to which Protanium® Steel is produced is a primary reason for the absolutely consistent performance of Bondhus tools. The strength, quality and durability of Bondhus tools does not vary from one tool to the next or from one purchase to the next. Bondhus believes that every tool it manufactures must perform with 100% consistency in order for the Bondhus reputation for 100% reliability to always be upheld.



# ProGuard™ Corrosion Protection

ProGuard™ dry surface protection is another Bondhus innovation that delivers superior corrosion protection. It is the most effective solution for protecting tools from rust and corrosion. The application process starts with a thorough cleaning of the tool. A proprietary process is then used to grow a very tight and small grained crystal structure on the surface of the tool. Additionally, a fast drying oil is added to provide an additional level of corrosion protection. The resulting finish creates a surface that is very difficult for moisture or contaminants to penetrate. Results of comparative salt spray performance testing, conducted by an independent lab, provide dramatic proof that Bondhus ProGuard™ corrosion protection is up to five times more effective than competitor tool finishes.



2

## Features

- 1) ProGuard™ surface is impermeable to moisture and contaminants
- 2) Finish is dry and clean with a final light coating of oil
- 3) ProGuard™ finish is permanently bonded to surface of tool
- 4) Lifetime warranty

## Benefits

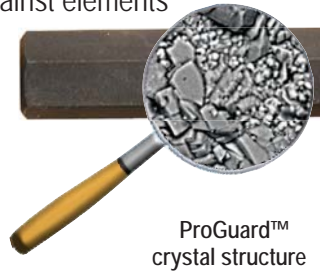
- 1) Tools remain in good condition with up to five times the resistance to rust and corrosion
- 2) Tool user's hands and work area stay clean and oil free.
- 3) ProGuard™ protection is a permanent solution that does not wipe off like common oil and black oxide finishes.
- 4) Bondhus stands behind every sale with a "No questions asked" lifetime replacement policy.

\* Bondhus, Bondhex, ProGuard, Protanium, Balldriver, BallStar, GorillaGrip, BriteGuard and GoldGuard are trademarks of Bondhus Corporation.

# ProGuard™ Corrosion Protection

## 1) ProGuard™ surface is impermeable to moisture and contaminants

ProGuard™ dry surface protection represents a dramatic improvement over traditional methods of protecting hex and Star tools. The ProGuard™ crystal structure provides a superior barrier against elements that cause rust and corrosion. It protects the tool for a lifetime of use and keeps tools looking attractive.



Independent lab testing has proven ProGuard™ finish is up to five times more effective at controlling corrosion than alternative finishes offered by competitors.

## 2) Finish is dry and clean with a final light coating of oil

**Bondhus:** The ProGuard™ finish locks out moisture and contaminants without the ongoing requirement of an oily surface. ProGuard™ tools receive a light coat of oil prior to packaging, but do not rely on oil as their primary means of protection. Tool user's hands and work areas remain dry and clean.

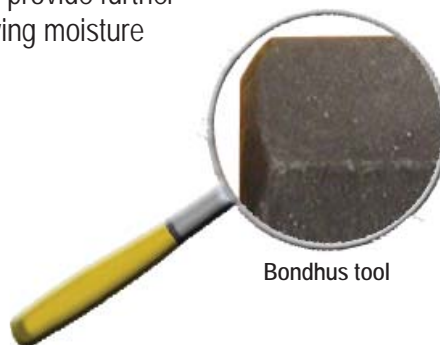
**Competitors:** Tools with inadequate protection rely on the user to keep the surface sealed with oil. Tools are dirty, messy and unpleasant to work with, and corrosion protection still remains inadequate.

## 3) ProGuard™ finish is permanently bonded to surface of tool

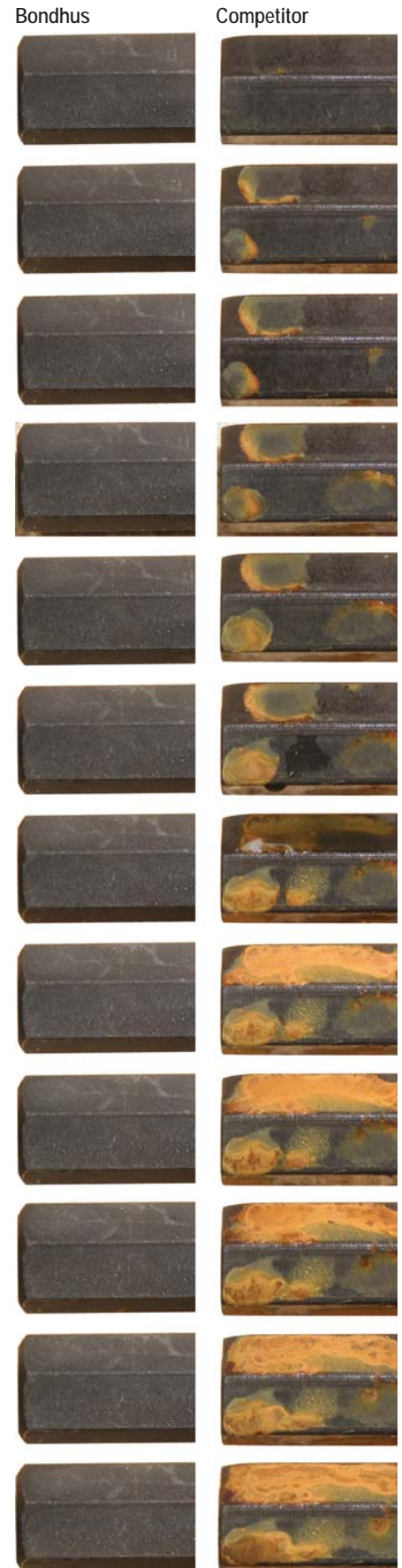
**Bondhus:** ProGuard™ protection is a proprietary finish only available on Bondhus tools. It provides a permanent finish that cannot be wiped off like a black oxide or oil finish.

Application of the ProGuard™ finish starts with a thorough caustic cleaning of the tool's surface. A small grained crystal structure is then permanently bonded to the entire surface of the tool through a ten step process. The resulting tight structure makes it very difficult for moisture and contaminants to penetrate the surface.

Smooth surfaces and sharp corners provide further protection to Bondhus tools by denying moisture and contaminants places to collect.



## 12 hour time-lapse moisture test sequence

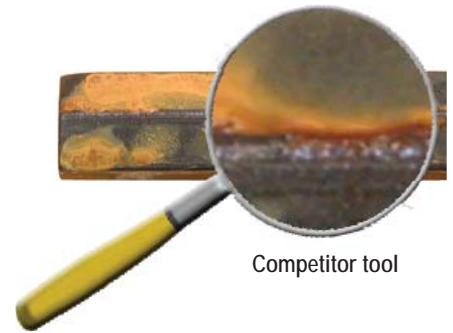


# ProGuard™ Corrosion Protection

**Competitors:** Three basic finishes are typically used by competitors. Each has associated deficiencies, and none is ideally suited for the professional tool market:

- Black oxide is a coating that forms on the surface of a tool through a chemical reaction with iron. It's commonly used on tools and forgings to create a dark gray or black color, but is both porous and easily wiped off. In spite of the coating of oil normally used on it, corrosion starts forming almost immediately, sometimes before the tool has even been removed from its packaging.
- Plating provides a degree of protection, but it eventually nicks, flakes or wears off, and allows water to seep in.
- Some manufacturers simply dip tools in oil. Once wiped off, tools are left with no protection whatsoever.

Competitor's tools lack the consistent smooth surfaces and sharp corners of Bondhus tools, so moisture can easily accumulate and accelerate the spread of corrosion in competitor tools.



**4) Lifetime warranty** Bondhus manufactures the highest quality hex and Star tools available, and every tool is backed by an unconditional lifetime warranty.

*"All Bondhus products are guaranteed for life. If you are not satisfied with a Bondhus tool - for any reason - simply return it. A replacement will be shipped right out at no cost - no hassles, no questions asked."*

A warranty is only as good as the company standing behind it. Bondhus has been the leading innovator in the hex and Star tool industry for over forty years.



# ProGuard™ Corrosion Protection

## Frequently Asked Questions

### *What is ProGuard™ protection?*

ProGuard™ protection is a proprietary corrosion protection finish available only from Bondhus. It keeps tools free from rust and corrosion, and according to results obtained by independent lab testing, provides up to five times more protection from corrosion than finishes available from competitors. A ProGuard™ finish also provides a pleasant feeling, slip resistant surface on tools.

### *Why is ProGuard™ protection better than black oxide?*

Black oxide is a porous finish allowing moisture and contaminants to easily penetrate the finish and damage tools. Black oxide is only a temporary finish, since it is easily wiped off on a towel when cleaning tools or onto the hands through normal use.

The ProGuard™ dry surface technology finish completely seals Bondhus tools from the contaminants that cause rust and corrosion. It is permanently bonded to the surface of the tool, and will not wipe off during cleaning or when using the tool.

### *Does ProGuard™ technology provide a durable finish?*

YES. A ten step process permanently bonds the ProGuard™ finish to the surface of the tool. It will not wipe off like black oxide or flake like plated finishes.

### *Can ProGuard™ protection be used in an autoclave?*

NO.



2

# Precision Design and Machining

A tool's effectiveness is directly proportional to how precisely it fits into a fastener. Every Bondhus tool is designed to achieve the optimal fit between tool and fastener. Each tool is then manufactured to the tightest tolerances in the hand tool industry. Tighter tolerances mean the best possible fit between the tool and the fastener. A precisely designed and manufactured Bondhus tool means longer life for both the tool and the fastener.



3

## Features

- 1) Precise fit in screw head
- 2) Sharp corners
- 3) Chamfered tool tips (straight hex and Star tips)
- 4) Precise machining
- 5) Consistent 25 degree working angle on ball end tools
- 6) Worlds strongest tools - Protanium® Steel
- 7) Worlds best corrosion protection- ProGuard™ Dry Surface Technology
- 8) Color coded handles (Screwdrivers, folding tools and T-Handles) & cases (for hex, ball and Star sets)
- 9) Bondhex™ case (for ball end, hex and Star key sets)
- 10) Lifetime warranty

## Benefits

- 1) Saves time because tool fits snug in the fastener, minimizing slippage and stripping. Tools generate greater torque without stripping. Tool and fastener wear is greatly reduced.
- 2) Saves time because tools have better engagement with fastener. Surface area contacting screw walls is increased. Tools and fasteners last longer and stripping is eliminated.
- 3) Saves time because burrs that might prevent insertion of the tool tip into the screw head are completely removed, so tip insertion is quick and easy. Tool tip seats to full depth in screw head.
- 4) Saves time because precision machining means every Bondhus tool fits precisely into the screw head, minimizing breakage and stripping.
- 5) Saves time because tool users can absolutely count on every Bondhus ball end tool to provide a full 25 degrees of working angle, period.
- 6) Saves time because Bondhus' exclusive Protanium® Steel makes Bondhus tools up to 20% stronger than competitor tools and allows the tool user to deliver more torque without breaking the tool or damaging the screw head
- 7) Saves time because the tool user does not have to work with rusty tools. ProGuard™ protection delivers up to 5 times the corrosion resistance of any other hex or Star tool finish.
- 8) Saves time because the tool user can quickly identify inch (yellow), metric (red) and Star (green) tools
- 9) Saves time because tools are neatly organized and locked in place to prevent loss. Tools are easily removed from the case with a slight twist of the tool.
- 10) Bondhus stands behind every sale with a "No questions asked" lifetime replacement policy.

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# Precision Design and Machining

## 1) Precise fit in screw head

In the simplest terms possible, the smaller the clearance between a tool tip and the walls of the screw socket, the longer the tip will wear, and the less likely stripping will occur. Smaller clearance simply means a greater surface area contacting the screw walls.

As simple as this concept may seem, there are major differences between the precision of Bondhus tools and those of competitors. A very thin strip of cellophane measures .001" (.025mm) in thickness and can be used to demonstrate this point.

**Bondhus:** A high quality hex tool starts with highly precise stock. The dimension across all flats on Protanium® Steel stock is extremely consistent because unlike any other competitor, Bondhus specifies and controls the drawing process. The gap between a Bondhus hex tip and each screw wall is typically .0005" (.0127mm) or less.

This strip of cellophane is less than .001" (.025mm) thick, but even a strip this thin will not fit between a Bondhus tool and a screw head. That is the kind of close tolerances you can expect from every single tool Bondhus manufactures. Tolerances and consistency like this are unheard of in the industry.

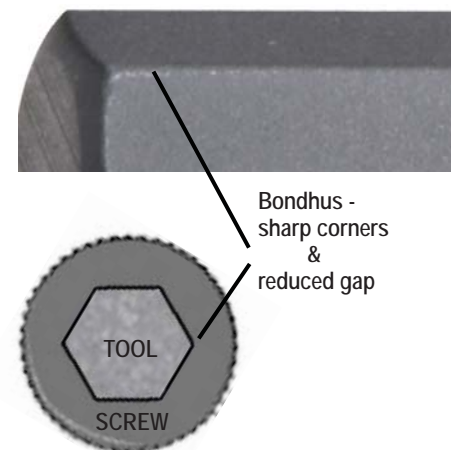
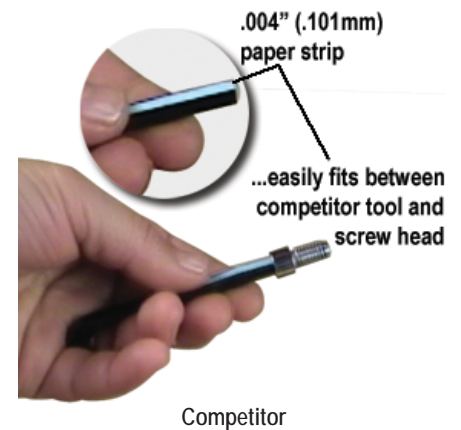
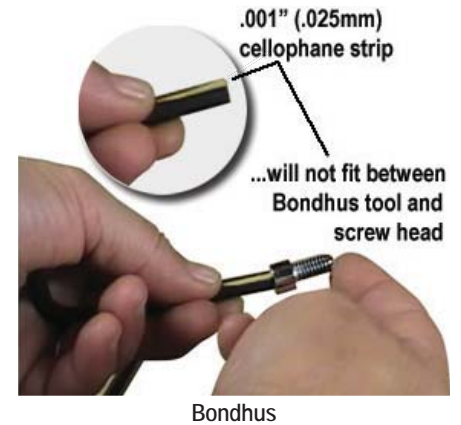
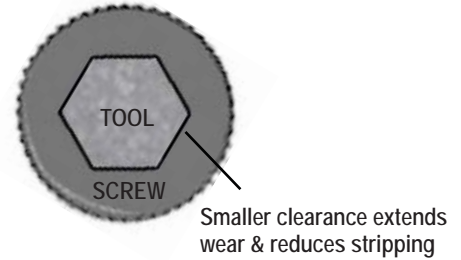
**Competitors:** Competitors all use standard grades of steel, so they have no control over the drawing process. Tolerances for dimensions across flats are not nearly as tight as Protanium® steel tolerances, so the gap between competitor's tips and the screw walls is often considerably greater. Dimensions from one flat to the next can vary, and even vary from one batch of steel to the next. Dimensional inconsistency is one of the factors accounting for excessive, inconsistent wear in many competitor tools.

A strip of paper .004" (.101mm) thick easily fits between this competitor's tip and the screw walls. That is four thousandths on each side, so this tool is actually eight thousandths smaller than the screw head. Over ten times the typical clearance allowed by the Bondhus specification!!

## 2) Sharp corners

**Bondhus:** Dimensions across corners are equally important as those across flats. Protanium® Steel tolerances imposed on the drawing process produce corners that are extremely smooth and sharp.

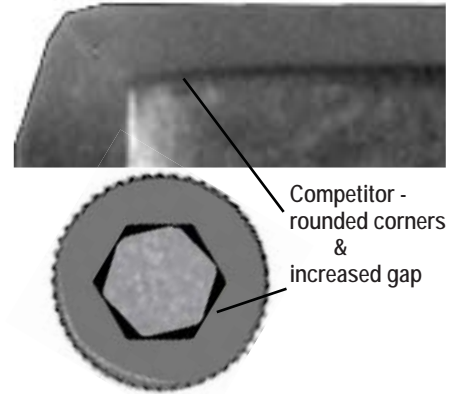
Corner gap on Bondhus tips is significantly reduced, so the surface area contacting the screw walls is increased. The increased surface area and the reduced gap are two primary reasons why Bondhus hex and Star tips have twice the wear resistance of competitor's tips and eliminate stripping. Fastener wear is also significantly reduced.



3

# Precision Design and Machining

**Competitors:** Tolerances for dimensions across corners of competitor's tips are not as tight as those of Protanium® Steel. In addition, corners are not as sharp as Bondhus corners and frequently exhibit pronounced rounding. The resulting gap between the tip and corner screw walls is thus increased. This is another major factor contributing to premature tip wear, accelerated fastener wear and ultimately stripping.



Competitor - rounded corners & increased gap

### 3) Chamfered tool tips (straight hex and Star tips)

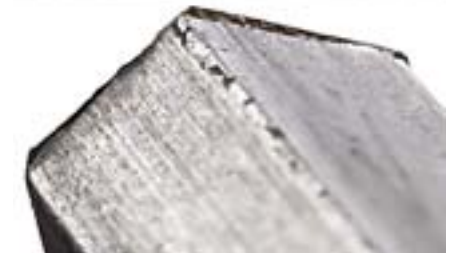
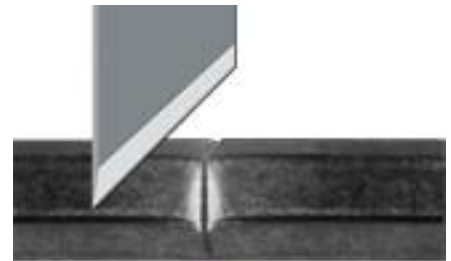
**Bondhus:** Bondhus uses a precise method of cutting, and then chamfers tips to eliminate any possibility of burrs. The chamfering makes insertion of a straight hex or Star tip into a screw head much easier. Bondhus employs several styles of chamfers, using each style where it is most effective. The type of chamfer used is not critical. The point is to ensure burrs are removed from all hex and Star keys. Bondhus hex and Star tips always insert smoothly and seat to full depth for optimal torque and longer tool life.



Chamfered Bondhus tip

**Competitors:** Imprecise methods of cutting produce burrs on the tips of hex and Star keys. It is common for burrs to be so large, they need to be filed away before the tool will insert into a screw head.

The clearance between a hex key and the screw walls is typically .0005" (.0127mm) or less on each side of the key, and even a very small burr can interfere with or prevent insertion. If the socket of a screw head is on the small side of its tolerance, and the hex key is on the large side of its tolerance, any amount of burr will prevent proper insertion of the tip into the screw head.



Competitor: Imprecise cutting causes burrs on tips

Competitor tools often feel snug in a screw head when first used, and then feel loose after only a couple of uses. The reason this happens is their tips often contain burrs. The burrs make the tool initially feel snug, but as soon as they wear off, the tips loose fit becomes obvious, and it proceeds to wear both the tool tip and the screw head quickly.

An imprecise cutting process can also distort the tool tip, causing it to be undersized, and to be slightly bent. Even chamfering or filing will not correct a problem of this severity.



Competitor: Tip bent by cutting process

As a last consideration, the cutting process can produce what is known as lips on the tip of a tool. Protrusions of this nature will prevent the tip from seating to the full depth in the screw head, thus increasing wear and the potential for stripping both the tool and the screw head.



Competitor: Tip with lips will not seat to full depth

# Precision Design and Machining

## 4) Precise machining

**Bondhus:** Professional tool users recognize the Bondhus name as synonymous with quality, consistency and reliability. Bondhus is meticulous about quality and the enforcement of the tightest specifications in the hex and Star tool industry. Every tool Bondhus manufactures is subject to its own set of specifications and a company policy of no exceptions or deviations. Specifications are enforced by quality assurance testing at every stage of the manufacturing process.

Precision machining is critical for a ball end tool to function optimally. Understandably, the smaller a ball end tip is, the more complex the task of machining becomes.

Bondhus maintains incredibly tight tolerances and close clearances between ball end tips and the screw head walls. Bondhus machining accurately maintains the precise geometric shape of the ball on all six sides. Surfaces are smooth, and corners are sharp and clean, even on a tool as small as .050" (1.27mm).

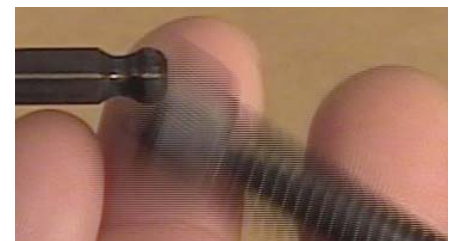
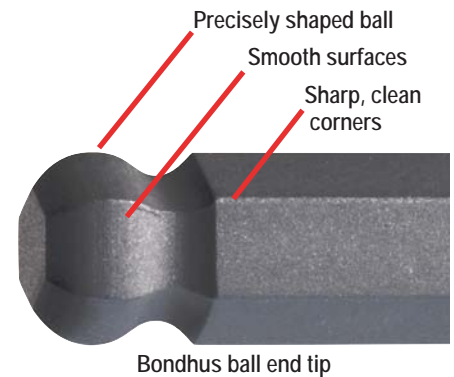
Precise machining results in Bondhus ball end tips having more surface area contacting the screw walls than any other competitor. Bondhus ball end tools far outwear the competition, and dramatically reduce stripping. Fastener wear is also greatly reduced.

**Competitors:** Claims of quality and precision are also made by competitors who often represent their tools as "comparable", "nearly comparable" or "good enough" when compared to Bondhus tools. Bondhus encourages head-to-head comparison and is pleased to provide all the information necessary for professional tool users to make their own informed decisions.

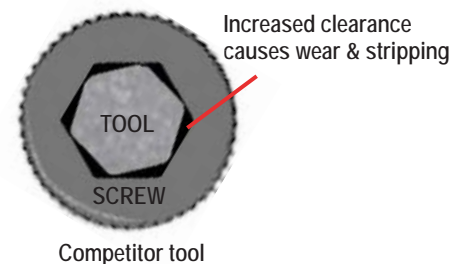
The ball end to the right is so poorly machined, it cannot even hold a screw in a horizontal position. Working in a blind or difficult location would be nearly impossible with this poorly machined tool tip.

Poorly machined ball ends do not just compromise working angle. Imprecise machining can cause tips to be under-sized and not symmetrical. The clearance between the tip and screw walls increases, causing excessive wear and stripping.

3



Competitor tool





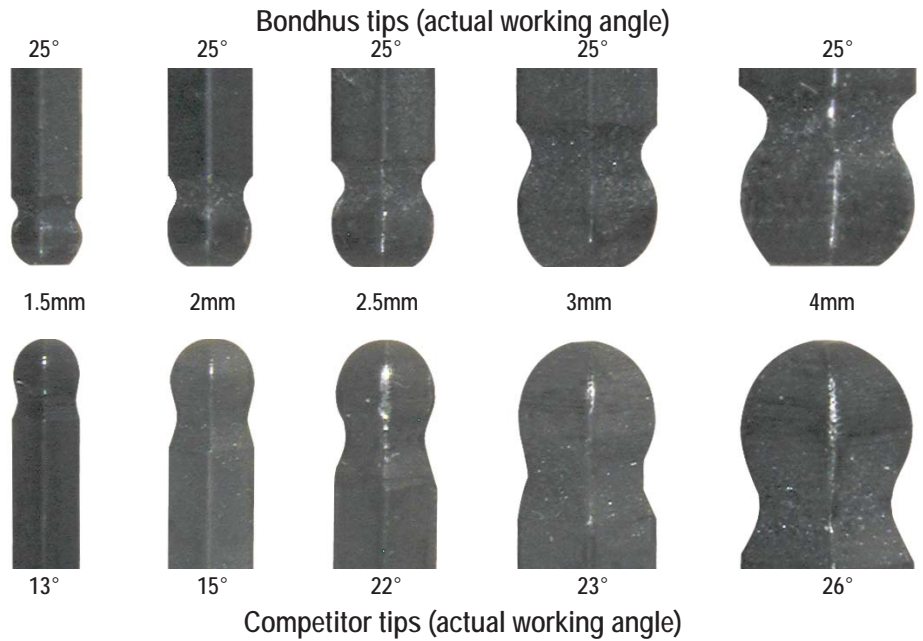
# Precision Design and Machining

## 5) Consistent 25 degree working angle on ball end tools

**Bondhus:** Bondhus ball end tips are precisely machined to provide a consistent 25 degrees of working angle, regardless of how large or small the tool is.

**Competitors:** Comparing Bondhus ball ends to those of a well known competitor, the differences are quite dramatic. Wide tolerances and imprecise machining cause many competitor ball ends to have an irregular ball shape. Wide variations in working angle from one tool to the next is the result, with some tools having less than 15° of working angle.

The competitor who manufactures these tools claims a 30° working angle. Actual measurement though, showed large inconsistencies from one tool to the next, and none were capable of reaching 30°.



# Precision Design and Machining

## 6) *Worlds strongest tools -Protanium® Steel*

### ► **Protanium® High Torque Steel - a custom blended steel**

Protanium® Steel is much more than “just steel” and much more than a “name”. It is a commitment to producing a level of tool performance unmatched by any competitor. Protanium® High Torque Steel is not an 8650 grade of steel, it is not a form of S-2 and it is not a chrome-vanadium or chrome-moly type of steel. Protanium® High Torque Steel is custom mixed to a formula that is the result of many years of research and continuous development efforts. Bondhus’ customized heat treating processes are the key to bringing out the superior strength properties of Protanium® High Torque Steel. Attaining results that push beyond the accepted limits of performance requires the skill and years of research and development that Bondhus alone has committed itself to.



(For more in-depth information on Protanium® Steel, please refer to Section 1 on pages 1 - 16.)

### **Custom blended steel versus common grades of steel**

In the broadest possible terms, only two categories of steel are used in the manufacturing of hex and Star tools; custom blended steel and standard grades of steel. A simple comparison makes it easy to see why Bondhus custom blended Protanium® Steel achieves far greater levels of performance than standard grades of steel:

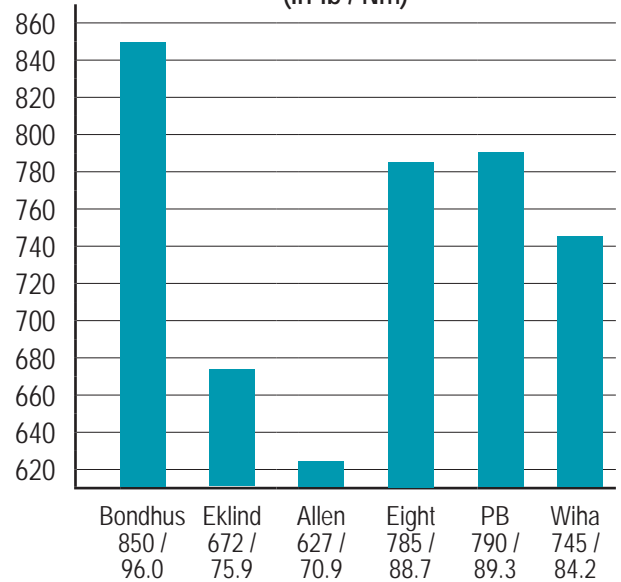
Custom blended Protanium® Steel	Standard grades of steel
A custom blend specifically designed for the rigors and requirements of hex and Star tools	Standard grades of steel are a one-size-fits-all solution, designed for a range of uses, not just hex and Star tools
The elements making up the steel's composition and the process used to produce the steel are customized to the Protanium® Steel specification, enabling use of customized heat treating processes that produce tools with greater hardness and ductility	The tool manufacturer has no control over the steel's blend. Heat treating cannot be customized beyond the limitations of the standard blend
Imperfections are eliminated through the addition of specific elements and by controlling the methods by which mills produce the steel	Tool manufacturer has no control over the steel's production or imperfections that may result
Meticulous quality control, monitoring and documentation are enforced by the Protanium® Steel specification	Steel mills perform their own “standard” quality control
The drawing process is controlled to produce stock with highly precise dimensional accuracy, sharp corners and smooth clean surfaces	Tool manufacturer has little control over drawing process

# Precision Design and Machining

Except for Bondhus, all other hex and Star tool manufacturers use various standard grades of steel in the manufacturing of their tools:

- 8650 is the most common grade in use throughout the U.S. and Asia. It does not achieve the hardness or ductility levels of Protanium® steel.
- Chrome Vanadium is comparable in performance to 8650. It is used primarily in Europe.
- Chrome Moly is similar to Chrome Vanadium, but is somewhat stronger and harder. Because it is fairly expensive, manufacturers generally only use it on their higher priced tools like ball end products, and substitute lower grades for their hex and folding tools. Europe and Japan are the primary users.
- S2 is used by only a small number of manufacturers. It is harder than 8650, but it is also less ductile, more costly, and far more prone to shattering.
- Carbon steel grades, such as 1050, are low-grade steels that are inferior to those listed above. They are still used by some manufacturers in Europe and Asia.

Average 6mm Hex Key Torque  
(In-lb / Nm)



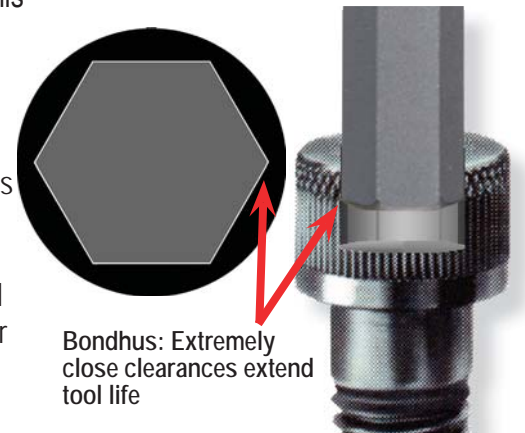
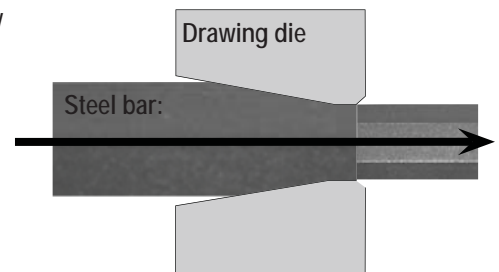
## ► *Bondhus controlled steel drawing process*

Changing the size or shape of a metal bar or rod by pulling it through a die is known as drawing. It is a critical process in the production of high quality steel, since it determines the dimensional precision and surface quality of the steel.

Standard grades of steel are drawn to tolerances that do not conform to the Protanium® Steel specification for precision, so Bondhus exercises full control over the drawing process. Bondhus works closely with its' steel suppliers to ensure 100% compliance with the Protanium® Steel drawing specification, and will not work with any mill unwilling to make this commitment.

### Close clearances

Tolerances imposed by the Protanium® Steel drawing specification produce stock so precisely drawn that clearances between a Bondhus tool tip and the screw walls is typically one half thousandth of an inch or less. Clearances this close produce tool tips with greater surface area contacting the screw walls. Smaller clearances between the tool surface and the screw head mean Bondhus tools greatly reduce wear of tool tips and screw heads, and reduce or eliminate the potential of stripping.



# Precision Design and Machining

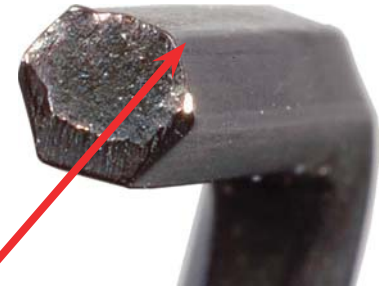
## Sharp corners

Another requirement of the Protanium® Steel drawing specification is that corners be sharp and smooth. Eliminating gaps between the tool tip corners and the screw walls means tool tip surface area increases. Tool tip and screw head wear is greatly reduced, since the primary cause of screw stripping has been eliminated.

Standard grades of steel allow far more rounding of corners during the drawing process and surfaces that are not nearly as smooth, so the process of tool wear and screw stripping is accelerated. Once again, tools made with standard grades of steel perform inconsistently and unreliably.



Bondhus: Sharp, clean corners

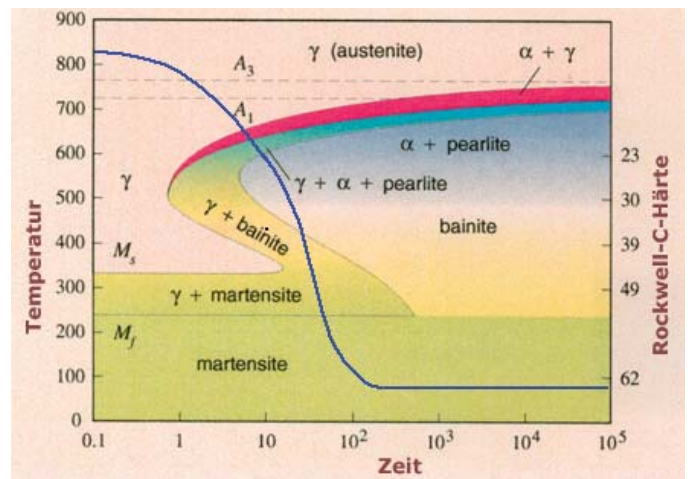


Competitors: Rounded corners accelerate wear and stripping

3

## ► Customized heat treating process assures optimal combination of hardness and ductility

Heat treating is a series of processes where steel is heated to a temperature referred to as its *transformation point*, where its atomic structure actually changes. It is then cooled (quenched) in a highly controlled process where it is held at a specific *temperature* for a precise period of *time*. Complex documents known as TTT Charts (Time / Temperature / Transform) show this relationship. They assist in determining an optimal heating and quenching cycle for obtaining desired properties such as optimal microstructure, grain size, hardness and ductility.



Sample TTT chart

## Truly customized heat treating

An essential point to understand about heat treating is that the blend of the steel largely determines how and to what extent desired properties of the steel can be obtained in the heat treating process. In other words, controlling and customizing the blend of the steel is the only means by which truly customized heat treating can be accomplished. Protanium® Steel starts as a custom blended steel, and is transformed into hard, ductile tools by customized heat treat processes.

- Competitors must perform their heat treating to accommodate the limitations of the standard grades of steel they purchase. Since they have no control over the blend of the steel, their heat treating cannot achieve the levels of hardness and ductility achieved by Protanium® Steel.
- Bondhus continually improves the blend of Protanium® Steel to achieve full customization of the heat treating process. With full control of the steel's blend and its heat treating, Protanium® Steel is capable of achieving levels of hardness and ductility well beyond the limitations of the standard grades of steel used by competitors

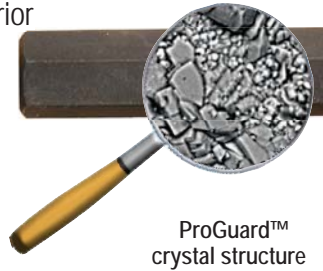


# Precision Design and Machining

## 7) *World's best corrosion protection - ProGuard™ Dry Surface Technology*

### ► **ProGuard™ surface is impermeable to moisture and contaminants**

ProGuard™ dry surface protection represents a dramatic improvement over traditional methods of protecting hex and Star tools. The ProGuard™ crystal structure provides a superior barrier against elements that cause rust and corrosion. It protects the tool for a lifetime of use and keeps tools looking attractive.



Independent lab testing has proven ProGuard™ finish is up to five times more effective than alternative finishes offered by competitors.

### ► **Finish is dry and clean with a final light coating of oil**

**Bondhus:** The ProGuard™ finish locks out moisture and contaminants without the ongoing requirement of an oily surface. ProGuard™ tools receive a light coat of oil prior to packaging, but do not rely on oil as their primary means of protection. Tool user's hands and work areas remain dry and clean.

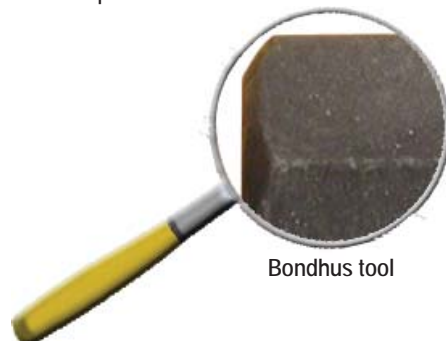
**Competitors:** Tools with inadequate protection rely on the user to keep the surface sealed with oil. Tools are dirty, messy and unpleasant to work with, and corrosion protection still remains inadequate.

### ► **ProGuard™ finish is permanently bonded to surface of tool**

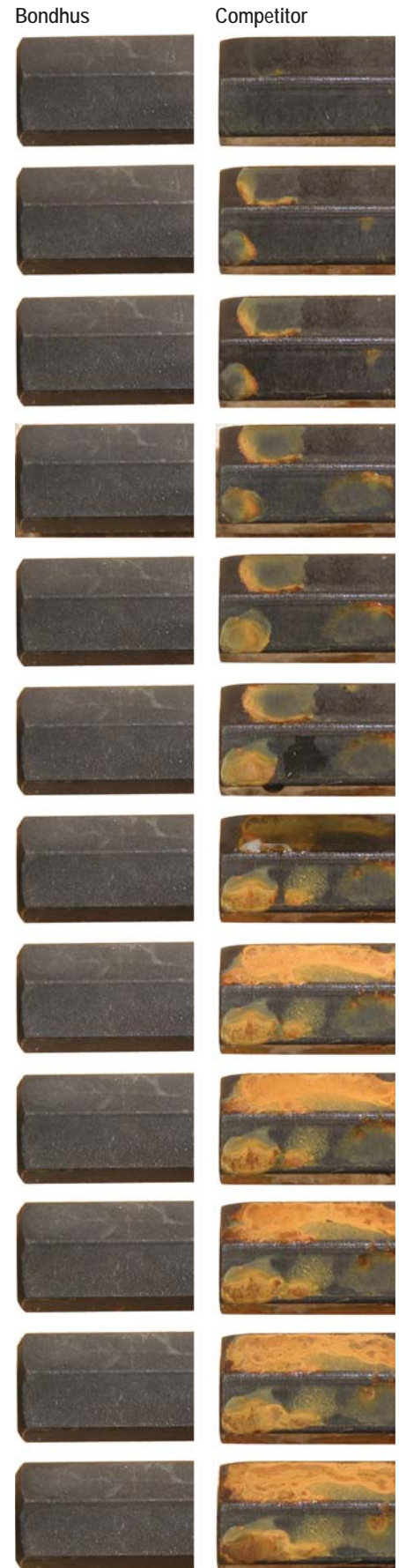
**Bondhus:** ProGuard™ protection is a proprietary finish only available on Bondhus tools. It provides a permanent finish that cannot be wiped off like a black oxide or oil finish.

Application of the ProGuard™ finish starts with a thorough caustic cleaning of the tool's surface. A small grained crystal structure is then permanently bonded to the entire surface of the tool through a ten step process. The resulting tight structure makes it very difficult for moisture and contaminants to penetrate the surface.

Smooth surfaces and sharp corners provide further protection to Bondhus tools by denying moisture and contaminants places to collect.



## 12 hour time-lapse moisture test sequence

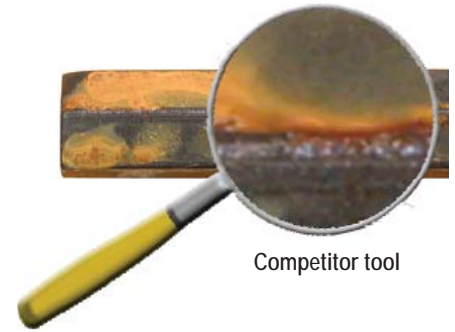


# Precision Design and Machining

**Competitors:** Three basic finishes are typically used by competitors. Each has associated deficiencies, and none is ideally suited for the professional tool market:

- Black oxide is a coating that forms on the surface of a tool through a chemical reaction with iron. It's commonly used on tools and forgings to create a dark gray or black color, but is both porous and easily wiped off. In spite of the coating of oil normally used on it, corrosion starts forming almost immediately, sometimes before the tool has even been removed from its packaging.
- Plating provides a degree of protection, but it eventually nicks, flakes or wears off, and allows water to seep in.
- Some manufacturers simply dip tools in oil. Once wiped off, tools are left with no protection whatsoever.

Competitor's tools lack the consistent smooth surfaces and sharp corners of Bondhus tools, so moisture can easily accumulate and accelerate the spread of corrosion in competitor tools.

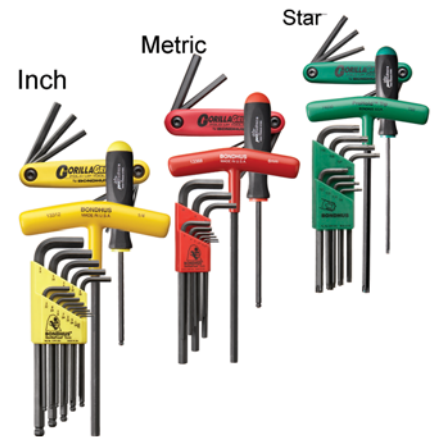


Competitor tool

## 8) Color coded handles (screwdrivers, folding tools and T-Handles) & cases (for hex, ball and Star sets)

Color coding of T-Handle and screwdriver handles and Bondhex™ cases makes inch, metric and Star tools easy to identify and distinguish from one another.

Inch	-	yellow
Metric	-	red
Star	-	green



9) **Bondhex™ case (for ball end, hex and Star key sets)** Bondhus ball end, hex and Star key sets include the color coded Bondhex™ case to keep tools neat and sorted. A simple 60 degree turn locks keys in place to eliminate loose, spilled and lost keys, and tool sizes are clearly printed beneath each tool for quick size selection. A Bondhex™ case can also be used with a hex key to increase grip and comfortably generate additional torque.



10) **Lifetime warranty** Bondhus manufactures the highest quality hex and Star tools available, and every tool is backed by an unconditional lifetime warranty.

*"All Bondhus products are guaranteed for life. If you are not satisfied with a Bondhus tool - for any reason - simply return it. A replacement will be shipped right out at no cost - no hassles, no questions asked."*

A warranty is only as good as the company standing behind it. Bondhus has been the leading innovator in the hex and Star tool industry for over forty years.



# Precision Design and Machining

## Frequently Asked Questions

### *Why does Bondhus have different types of chamfers?*

Bondhus chamfers all hex and Star tips. Regardless of the chamfer type (appearance), its function is to remove any possibility of burrs and ease tip entry into a screw head. Bondhus employs several types of chamfers, using each style where it is most effective.

### *What is the purpose of the ball on ball end tools?*

Access and time-savings are the two primary reasons Bondhus invented the ball end. A straight hex tool can only enter a screw head from a straight-on direction. A Bondhus ball end though, can enter from up to a 25 degree angle, providing easy access to screws that cannot be inserted or removed with the straight-on limitation of a hex tip. Reaching screws that would otherwise require disassembly of equipment to gain access to the screws becomes quick and easy. This is especially true when working in blind or difficult to reach locations.

A Bondhus ball end also saves time because it provides quicker and easier entry into a screw head than what a hex tip would. When working near an obstruction that would require removing, repositioning and re-inserting a hex tip tool, a ball end again saves time. The ball end tool can be positioned at an angle to the screw head, to avoid the obstruction, and the tool can be rotated continuously, with no need to remove it with every revolution of the tool.

### *Do Bondhus hex keys fit tighter in screw heads than competitor tools?*

YES! Bondhus hex and Star tools are highly precise, with extremely close clearance between the tool and screw head walls, but they are never "tight" and never "loose". They will always slide smoothly into a screw head, even though typical clearance between a Bondhus tool and the screw walls is less than one half thousandth of an inch (.0127mm).

# Ball End Tools

Bondhus ball end tools are designed and manufactured to be strong and save time. Bondhus invented the ball end tip for use with socket screws and has achieved the ideal combination of angle and strength. Bondhus ball ends rotate smoothly in a screw head at up to 25 degrees. Bondhus' exclusive manufacturing processes ensure the highest level of machining consistency as each ball end is machined to incredibly tight tolerances. All Bondhus ball end tools are manufactured with Bondhus' exclusive Protanium® Steel, which is up to 20% stronger than competitor tools and are available in many different corrosion protection finishes. Bondhus ball end tools are available in thousands of different individual tool or set combinations.



4

## Features

- 1) Ball ends insert into screws at an angle
- 2) Tools available for very small sizes:  
As small as .050" & 1.27mm  
As small as T6 (BallStar™ tip)
- 3) Tools work at a 25 degree angle
- 4) Superior ball end strength and working angle
- 5) Funnel insertion
- 6) Chamfered tool tips (short arm on ball end hex keys)
- 7) Precise machining
- 8) Consistent 25 degree working angle on ball end tools
- 9) Handles matched to tip torque (Screwdrivers and T-Handles)
- 10) Worlds strongest tools -Protanium® Steel
- 11) Worlds best corrosion protection - ProGuard™ Dry Surface Technology
- 12) Color coded handles (Screwdrivers, folding tools and T-Handles) & cases (for hex, ball and Star sets)

## Benefits

- 1) Saves time because tool user can reach and turn screws that cannot be reached straight-in
- 2) Bondhus' extremely precise manufacturing methods create tools that work very well, even in very small sizes
- 3) Screws can be turned continuously, without constantly taking the tool out of the screw, repositioning it and reinserting it, even at angles up to 25 degrees.
- 4) Bondhus ball end tips are designed to be the perfect balance between angle and strength. Ball end strength is maximized, while still providing a consistent full 25 degrees of working angle.
- 5) Saves time because Bondhus ball ends automatically funnel themselves into the screw head and quickly seat to full depth
- 6) Saves time because burrs that might prevent insertion of the tool tip into the screw head are completely removed, so tip insertion is quick and easy. Tool tip seats to full depth in screw head.
- 7) Saves time because precision machining means every Bondhus tool fits precisely into the screw head, minimizing breakage and stripping
- 8) Saves time because tool users can absolutely count on every Bondhus ball end tool to provide a full 25 degrees of working angle, period.
- 9) T-Handle and screwdriver handles are sized to comfortably deliver an appropriate level of torque and assist in preventing damage to ball end tips.
- 10) Saves time because Bondhus' exclusive Protanium® Steel makes Bondhus tools up to 20% stronger than competitor tools and allows the tool user to deliver more torque without breaking the tool or damaging the screw head.
- 11) Saves time because the tool user does not have to work with rusty tools. ProGuard™ protection delivers up to 5 times the corrosion resistance of any other hex or Star tool finish.
- 12) Saves time because the tool user can quickly identify inch (yellow), metric (red) and Star (green) tools



# Ball End Tools

## Features

- 13) Bondhex™ case (for ball end, hex and Star key sets)
- 14) Lifetime warranty
- 15) ProGuard™ (black), BriteGuard™ (chrome) and GoldGuard™ (14k gold) finishes

## Benefits

- 13) Saves time because tools are neatly organized and locked in place to prevent loss. Tools are easily removed from the case with a slight twist of the tool.
- 14) Bondhus stands behind every sale with a “No questions asked” lifetime replacement policy
- 15) Tool users have a wide range of finish choices to fit virtually every need.

\* Bondhus, Bondhex, ProGuard, Protanium, Balldriver, BallStar, GorillaGrip, BriteGuard and GoldGuard are trademarks of Bondhus Corporation.

# Ball End Tools

**1) Ball ends insert into screws at an angle** Bondhus ball end tools are tremendous time savers. A hex or Star tip tool can only be inserted in a screw head from a straight-on direction (0 degrees), but a Bondhus ball end tip can enter from any angle up to 25 degrees, and insertion is quick and easy. The need to disassemble equipment to provide tool access to a screw head can be reduced or eliminated.



**2) Tools available for very small sizes:**  
*As small as .050" & 1.27mm (ball end hex)*  
*As small as T6 (BallStar™ tip)*

Bondhus manufactures a broad selection of ball end hex and ball end Star tools for precision applications. Even in these incredibly small sizes, Bondhus tools maintain tight tolerances, highly precise machining and absolute consistency.

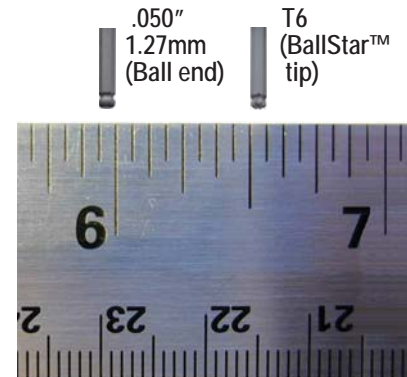
Bondhus precision machined tools will not strip fasteners, wear prematurely or damage delicate equipment to which repairs would be expensive and time consuming. Tool users can feel confident that Bondhus tools have the strength and precision to protect even their most delicate and expensive components.

**3) Tools work at up to a 25 degree angle (ball end tools)**

Working with a hex or Star tool, near obstructions that block 360 degrees of handle rotation, can consume significant amounts of time. A standard hex or Star tool must be removed and reinserted with every rotation of the screw, and often, screws can only be turned a fraction of a rotation at a time.

**Bondhus:** When using a Bondhus ball end tool, the time and effort of working in those difficult blind or hard to reach locations is greatly reduced. A Bondhus ball end can provide continuous rotation, eliminating the time-consuming need to constantly remove and reinsert the tool.

Angle insertion of a screw requires a sensitive feel to know when the thread has been started straight. This is especially important when working with small screw sizes, or inserting screws into soft materials like aluminum or plastic, which are prone to cross-threading. Bondhus ball ends minimize the possibility of cross-threading by providing a full 360 degrees of smooth rotation and preserving rotational sensitivity.



Hex tool constantly removed and re-inserted



Ball end tool provides continuous rotation



# Ball End Tools

**Competitors:** An imprecisely machined ball end can deliver reduced working angle and can sacrifice smooth rotation, and in turn, not provide the sensitive feel necessary for starting a thread straight. Cross-threading can easily occur, and re-tapping a thread in a difficult location often requires time-consuming disassembly of equipment.



Competitor tool: Imprecise machining sacrifices smooth rotation

Some ball ends are not only poorly machined, they are also undersized. They can rotate smoothly only because of excessive clearance between the tip and socket walls, and give a misleading feel of precision. In just a short time, they will wear excessively, and stripping of the ball end or screw head will be the outcome.

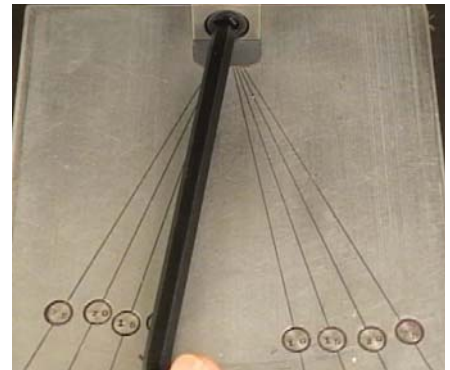


Competitor tool: Imprecise machining causes undersized tips

## 4) Superior ball end strength and working angle

"Working angle" is the maximum angle at which a ball end can operate smoothly, while fully seated in the screw head. A quality ball end tool must provide good working angle without compromising neck strength. Bondhus ball end tools are designed to deliver a full 25 degrees of working angle, while delivering maximum neck strength.

**Competitors:** Competitors manufacture ball ends from common grades of steel that lack the strength of Bondhus Protanium® Steel. To compensate for inadequate strength, some manufacturers *increase* neck size. As neck size increases, however, working angle *decreases*. Strength is improved, but working angle becomes inadequate.



Competitor tool: Thick neck limits working angle to only 9°

To achieve working angles up to 35°, some manufacturers *reduce* neck size. Reduced neck size decreases strength, and as the recommended seating torque for the screw is approached, the risk of breakage increases. A broken tip can mean a substantial loss of time if the broken ball end jams itself in the screw head or damages the screw head.

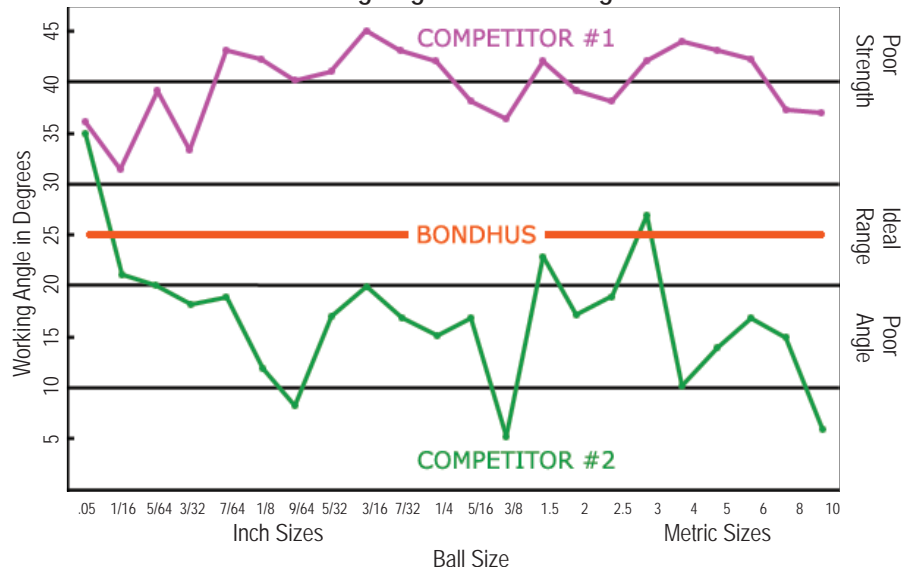


Competitor tool: Thin neck size risks breakage

**Bondhus:** Bondhus ball end tools achieve the ideal balance between working angle and strength. The strength of Protanium® Steel allows a neck size that delivers a full 25 degrees of working angle, while maintaining superior strength and wear resistance.

A blade with a hex tip begins to yield when maximum torque is reached. The tool user can easily feel that yield, and by not applying additional torque, breakage can be avoided. In contrast, a ball end tip provides no warning of impending breakage to the tool user. When over-torqued, it breaks without warning. This is one of the reasons why the strength of a Protanium® Steel ball end is such an important feature.

Ball End Comparison  
Working Angle Versus Strength



# Ball End Tools

## 5) Funnel insertion

Bondhus ball ends insert smoothly and are faster and easier to insert into a screw head than a hex tip. The concept by which the ball end channels itself into a screw head is known as funnel insertion. Precise design and machining ensure that the sides of the ball funnel the tip into the screw head and seat to full depth.



## 6) Chamfered tool tips (short arm on ball end hex keys)

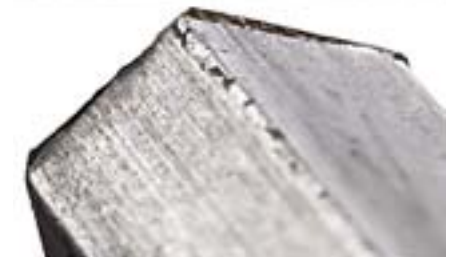
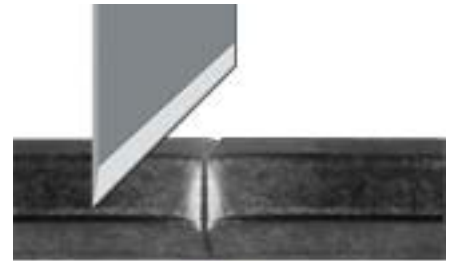
**Bondhus:** Bondhus uses a precise method of cutting, and then chamfers tips to eliminate any possibility of burrs. The chamfering makes insertion of a straight hex or Star tip into a screw head much easier. Bondhus employs several styles of chamfers, using each style where it is most effective. The type of chamfer used is not critical. The point is to ensure burrs are removed from all hex and Star keys. Bondhus hex and Star tips always insert smoothly and seat to full depth for optimal torque and longer tool life.



Chamfered Bondhus tip

**Competitors:** Imprecise methods of cutting produce burrs on the tips of hex and Star keys. It is common for burrs to be so large, they need to be filed away before the tool will insert into a screw head.

The clearance between a hex key and the screw walls is typically .0005" (.0127mm) or less on each side of the key, and even a very small burr can interfere with or prevent insertion. If the socket of a screw head is on the small side of its tolerance, and the hex key is on the large side of its tolerance, any amount of burr will prevent proper insertion of the tip into the screw head.



Competitor: Imprecise cutting causes burrs on tips

Competitor tools often feel snug in a screw head when first used, and then feel loose after only a couple of uses. The reason this happens is their tips often contain burrs. The burrs make the tool initially feel snug, but as soon as they wear off, the tips loose fit becomes obvious, and it proceeds to wear both the tool tip and the screw head quickly.

An imprecise cutting process can also distort the tool tip, causing it to be undersized, and to be slightly bent. Even chamfering or filing will not correct a problem of this severity.



Competitor: Tip bent by cutting process

As a last consideration, the cutting process can produce what is known as lips on the tip of a tool. Protrusions of this nature will prevent the tip from seating to the full depth in the screw head, thus increasing wear and the potential for stripping both the tool and the screw head.



Competitor: Tip with lips will not seat to full depth



# Ball End Tools

## 7) Precise machining

**Bondhus:** Professional tool users recognize the Bondhus name as synonymous with quality, consistency and reliability. Bondhus is meticulous about quality and the enforcement of the tightest specifications in the hex and Star tool industry. Every tool Bondhus manufactures is subject to its own set of specifications and a company policy of no exceptions or deviations. Specifications are enforced by quality assurance testing at every stage of the manufacturing process.

Precision machining is critical for a ball end tool to function optimally. Understandably, the smaller a ball end tip is, the more complex the task of machining becomes.

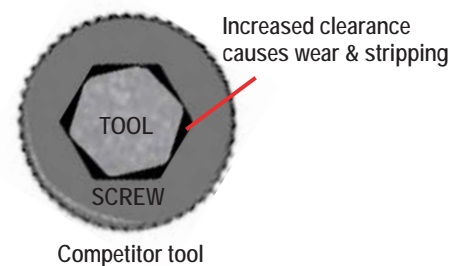
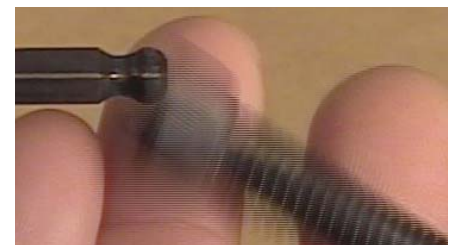
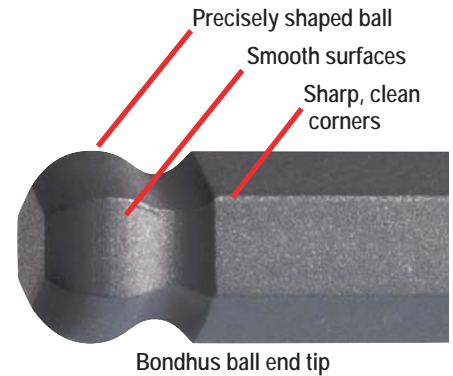
Bondhus maintains incredibly tight tolerances and close clearances between ball end tips and the screw head walls. Bondhus machining accurately maintains the precise geometric shape of the ball on all six sides. Surfaces are smooth, and corners are sharp and clean, even on a tool as small as .050" (1.27mm).

Precise machining results in Bondhus ball end tips having more surface area contacting the screw walls than any other competitor. Bondhus ball end tools far outwear the competition, and dramatically reduce stripping. Fastener wear is also greatly reduced.

**Competitors:** Claims of quality and precision are also made by competitors who often represent their tools as "comparable", "nearly comparable" or "good enough" when compared to Bondhus tools. Bondhus encourages head-to-head comparison and is pleased to provide all the information necessary for professional tool users to make their own informed decisions.

The ball end to the right is so poorly machined, it cannot even hold a screw in a horizontal position. Working in a blind or difficult location would be nearly impossible with this poorly machined tool tip.

Poorly machined ball ends do not just compromise working angle. Imprecise machining can cause tips to be under-sized and not symmetrical. The clearance between the tip and screw walls increases, causing excessive wear and stripping.



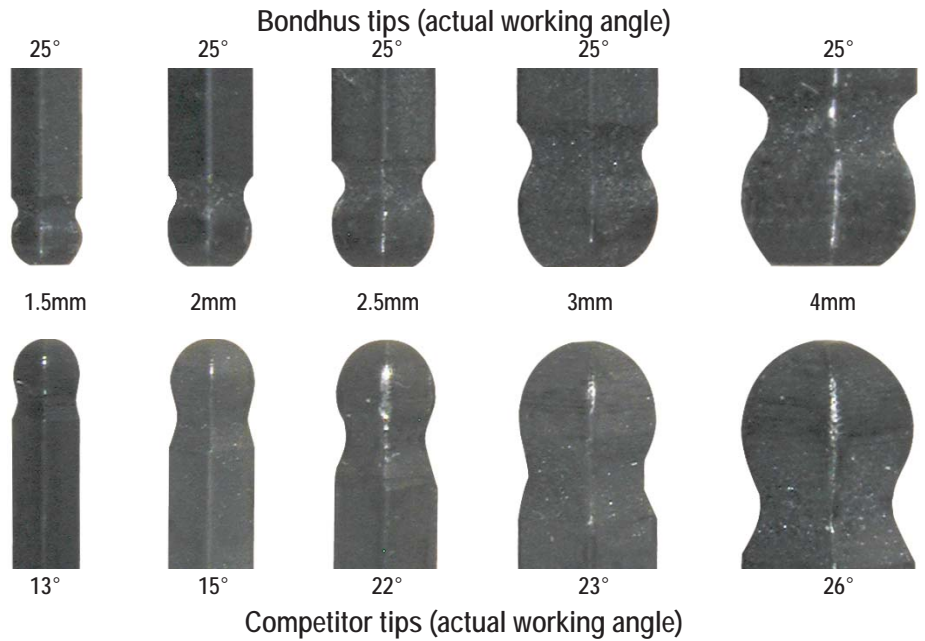
# Ball End Tools

## 8) Consistent 25 degree working angle on ball end tools

**Bondhus:** Bondhus ball end tips are precisely machined to provide a consistent 25 degrees of working angle, regardless of how large or small the tool is.

**Competitors:** Comparing Bondhus ball ends to those of a well known competitor, the differences are quite dramatic. Wide tolerances and imprecise machining cause many competitor ball ends to have an irregular ball shape. Wide variations in working angle from one tool to the next is the result, with some tools having less than 15° of working angle.

The competitor who manufactures these tools claims a 30° working angle. Actual measurement though, showed large inconsistencies from one tool to the next, and none were capable of reaching 30°.



## 9) Handles matched to tip torque (screwdrivers and T-Handles)

**Bondhus:** A screwdriver is capable of over-torquing its blade and can easily result in damage to the tool. Bondhus is the only manufacturer to design handles matched to the torque capacity of their blades and tips. Whether using a hex, Star or ball end tip, tool users can feel confident that applying torque will not result in breakage or damage to a Bondhus screwdriver.

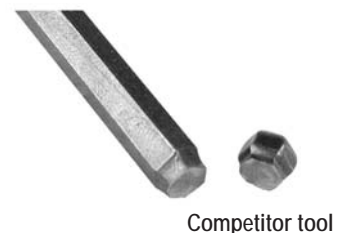


A T-Handle that is too large can easily generate too much torque and risk blade or tip damage. A T-Handle that is too small requires wasted effort to generate required torque, resulting in needless user fatigue. The handles on all Bondhus T-Handles are sized to strike a balance between ease of use and protection against tool damage. Handles are large enough to easily and comfortably generate needed torque, yet small enough to help prevent accidental over-torquing that could damage the blade or tip.

**Competitors:** Many screwdriver and T-Handle tools are available with handles that far exceed the torque capacity of their blades or tips. Damage and breakage, caused by over-torquing, is common to these tools.



A handle this large, is capable of generating more torque than this ball end tip can deliver. Without warning, the tip can easily be broken off.



Bondhus does not manufacture ball end T-Handles in sizes smaller than 5/32" and 4mm. A T-Handle could easily over-torque and break smaller size ball end tips. Hex tips are provided on tools of these sizes, in order to prevent tip damage.

Inch	Metric
3/32"	2mm
7/64"	2.5mm
1/8"	3mm
9/64"	

T-Handles with hex tips

# Ball End Tools

## 10) Worlds strongest tools -Protanium® Steel

### ► Protanium® High Torque Steel - a custom blended steel

Protanium® Steel is much more than “just steel” and much more than a “name”. It is a commitment to producing a level of tool performance unmatched by any competitor. Protanium® High Torque Steel is not an 8650 grade of steel, it is not a form of S-2 and it is not a chrome-vanadium or chrome-moly type of steel. Protanium® High Torque Steel is custom mixed to a formula that is the result of many years of research and continuous development efforts. Bondhus’ customized heat treating processes are the key to bringing out the superior strength properties of Protanium® High Torque Steel. Attaining results that push beyond the accepted limits of performance requires the skill and years of research and development that Bondhus alone has committed itself to.

(For more in-depth information on Protanium® Steel, please refer to Section 1 on pages 1 - 16.)

### Custom blended steel versus common grades of steel

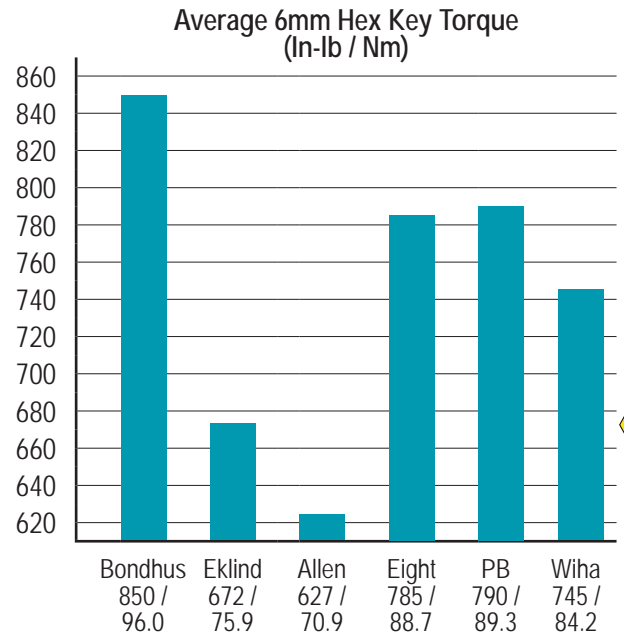
In the broadest possible terms, only two categories of steel are used in the manufacturing of hex and Star tools; custom blended steel and standard grades of steel. A simple comparison makes it easy to see why Bondhus custom blended Protanium® Steel achieves far greater levels of performance than standard grades of steel:

Custom blended Protanium® Steel	Standard grades of steel
A custom blend specifically designed for the rigors and requirements of hex and Star tools	Standard grades of steel are a one-size-fits-all solution, designed for a range of uses, not just hex and Star tools
The elements making up the steel's composition and the process used to produce the steel are customized to the Protanium® Steel specification, enabling use of customized heat treating processes that produce tools with greater hardness and ductility	The tool manufacturer has no control over the steel's blend. Heat treating cannot be customized beyond the limitations of the standard blend
Imperfections are eliminated through the addition of specific elements and by controlling the methods by which mills produce the steel	Tool manufacturer has no control over the steel's production or imperfections that may result
Meticulous quality control, monitoring and documentation are enforced by the Protanium® Steel specification	Steel mills perform their own “standard” quality control
The drawing process is controlled to produce stock with highly precise dimensional accuracy, sharp corners and smooth clean surfaces	Tool manufacturer has little control over drawing process

# Ball End Tools

Except for Bondhus, all other hex and Star tool manufacturers use various standard grades of steel in the manufacturing of their tools:

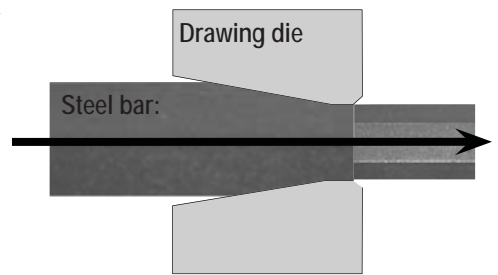
- 8650 is the most common grade in use throughout the U.S. and Asia. It does not achieve the hardness or ductility levels of Protanium® steel.
- Chrome Vanadium is comparable in performance to 8650. It is used primarily in Europe.
- Chrome Moly is similar to Chrome Vanadium, but is somewhat stronger and harder. Because it is fairly expensive, manufacturers generally only use it on their higher priced tools like ball end products, and substitute lower grades for their hex and folding tools. Europe and Japan are the primary users.
- S2 is used by only a small number of manufacturers. It is harder than 8650, but it is also less ductile, more costly, and far more prone to shattering.
- Carbon steel grades, such as 1050, are low-grade steels that are inferior to those listed above. They are still used by some manufacturers in Europe and Asia.



## ► *Bondhus controlled steel drawing process*

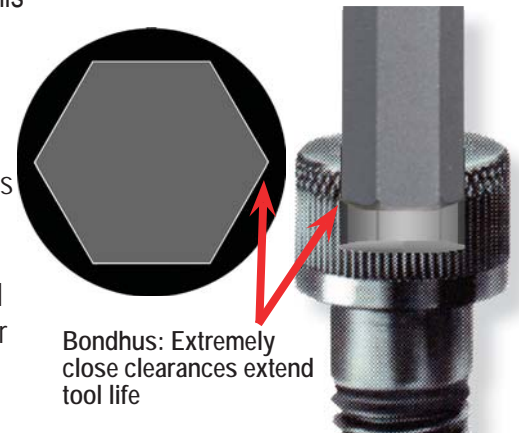
Changing the size or shape of a metal bar or rod by pulling it through a die is known as drawing. It is a critical process in the production of high quality steel, since it determines the dimensional precision and surface quality of the steel.

Standard grades of steel are drawn to tolerances that do not conform to the Protanium® Steel specification for precision, so Bondhus exercises full control over the drawing process. Bondhus works closely with its' steel suppliers to ensure 100% compliance with the Protanium® Steel drawing specification, and will not work with any mill unwilling to make this commitment.



## Close clearances

Tolerances imposed by the Protanium® Steel drawing specification produce stock so precisely drawn that clearances between a Bondhus tool tip and the screw walls is typically one half thousandth of an inch or less. Clearances this close produce tool tips with greater surface area contacting the screw walls. Smaller clearances between the tool surface and the screw head mean Bondhus tools greatly reduce wear of tool tips and screw heads, and reduce or eliminate the potential of stripping.





# Ball End Tools

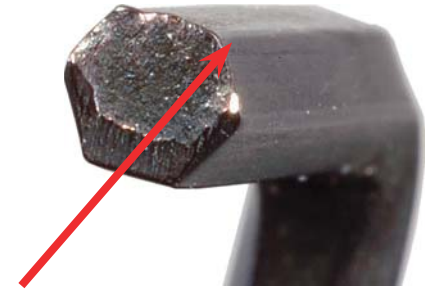
## Sharp corners

Another requirement of the Protanium® Steel drawing specification is that corners be sharp and smooth. Eliminating gaps between the tool tip corners and the screw walls means tool tip surface area increases. Tool tip and screw head wear is greatly reduced, since the primary cause of screw stripping has been eliminated.

Standard grades of steel allow far more rounding of corners during the drawing process and surfaces that are not nearly as smooth, so the process of tool wear and screw stripping is accelerated. Once again, tools made with standard grades of steel perform inconsistently and unreliably.



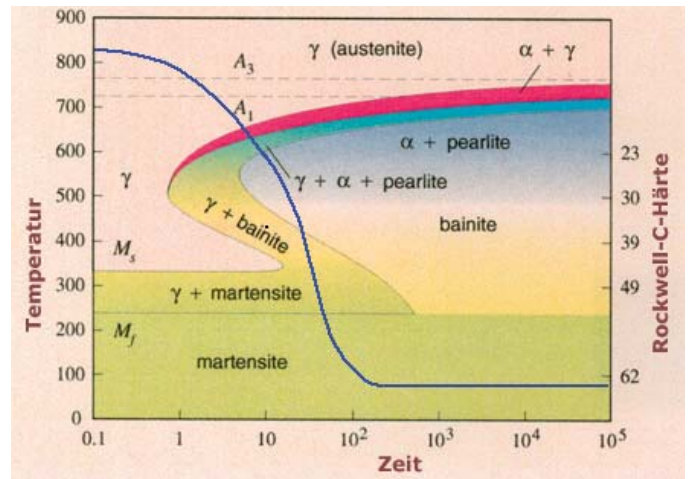
Bondhus: Sharp, clean corners



Competitors: Rounded corners accelerate wear and stripping

## ► Customized heat treating process assures optimal combination of hardness and ductility

Heat treating is a series of processes where steel is heated to a temperature referred to as its *transformation point*, where its atomic structure actually changes. It is then cooled (quenched) in a highly controlled process where it is held at a specific *temperature* for a precise period of *time*. Complex documents known as TTT Charts (Time / Temperature / Transform) show this relationship. They assist in determining an optimal heating and quenching cycle for obtaining desired properties such as optimal microstructure, grain size, hardness and ductility.



Sample TTT chart

## Truly customized heat treating

An essential point to understand about heat treating is that the blend of the steel largely determines how and to what extent desired properties of the steel can be obtained in the heat treating process. In other words, controlling and customizing the blend of the steel is the only means by which truly customized heat treating can be accomplished. Protanium® Steel starts as a custom blended steel, and is transformed into hard, ductile tools by customized heat treat processes.

- Competitors must perform their heat treating to accommodate the limitations of the standard grades of steel they purchase. Since they have no control over the blend of the steel, their heat treating cannot achieve the levels of hardness and ductility achieved by Protanium® Steel.
- Bondhus continually improves the blend of Protanium® Steel to achieve full customization of the heat treating process. With full control of the steel's blend and its heat treating, Protanium® Steel is capable of achieving levels of hardness and ductility well beyond the limitations of the standard grades of steel used by competitors

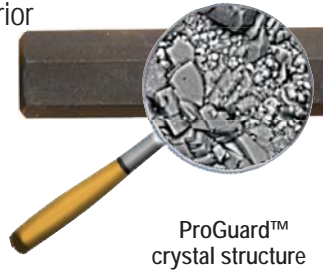


# Ball End Tools

## 11) Worlds best corrosion protection - ProGuard™ Dry Surface Technology

### ► ProGuard™ surface is impermeable to moisture and contaminants

ProGuard™ dry surface protection represents a dramatic improvement over traditional methods of protecting hex and Star tools. The ProGuard™ crystal structure provides a superior barrier against elements that cause rust and corrosion. It protects the tool for a lifetime of use and keeps tools looking attractive.



ProGuard™ crystal structure

Independent lab testing has proven ProGuard™ finish is up to five times more effective than alternative finishes offered by competitors.

### ► Finish is dry and clean with a final light coating of oil

**Bondhus:** The ProGuard™ finish locks out moisture and contaminants without the ongoing requirement of an oily surface. ProGuard™ tools receive a light coat of oil prior to packaging, but do not rely on oil as their primary means of protection. Tool user's hands and work areas remain dry and clean.

**Competitors:** Tools with inadequate protection rely on the user to keep the surface sealed with oil. Tools are dirty, messy and unpleasant to work with, and corrosion protection still remains inadequate.

### ► ProGuard™ finish is permanently bonded to surface of tool

**Bondhus:** ProGuard™ protection is a proprietary finish only available on Bondhus tools. It provides a permanent finish that cannot be wiped off like a black oxide or oil finish.

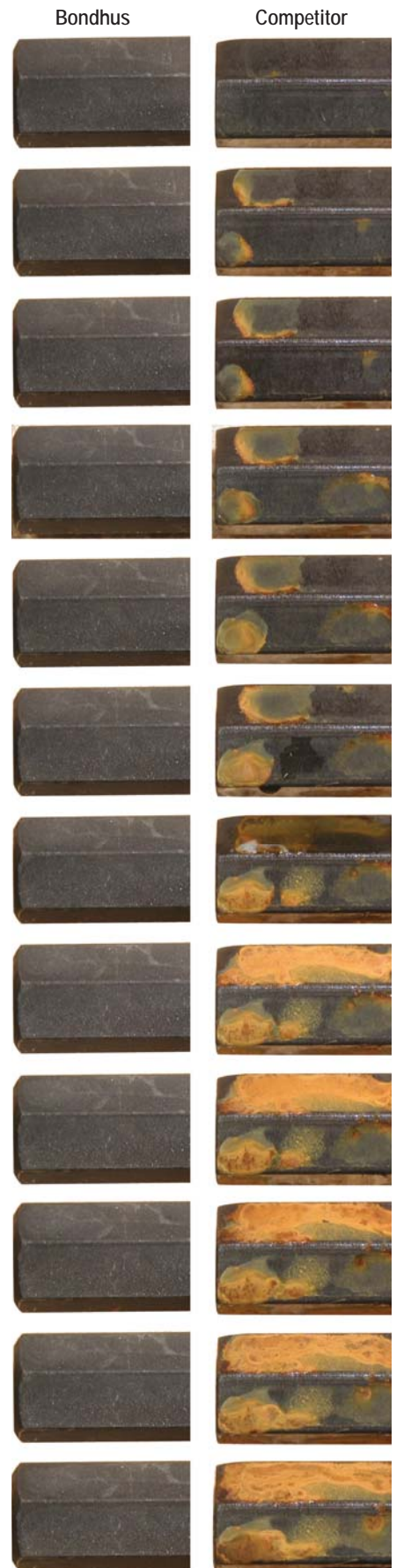
Application of the ProGuard™ finish starts with a thorough caustic cleaning of the tool's surface. A small grained crystal structure is then permanently bonded to the entire surface of the tool through a ten step process. The resulting tight structure makes it very difficult for moisture and contaminants to penetrate the surface.

Smooth surfaces and sharp corners provide further protection to Bondhus tools by denying moisture and contaminants places to collect.



Bondhus tool

## 12 hour time-lapse moisture test sequence



4

# Ball End Tools

► **Competitors:** Three basic finishes are typically used by competitors. Each has associated deficiencies, and none is ideally suited for the professional tool market:

- Black oxide is a coating that forms on the surface of a tool through a chemical reaction with iron. It's commonly used on tools and forgings to create a dark gray or black color, but is both porous and easily wiped off. In spite of the coating of oil normally used on it, corrosion starts forming almost immediately, sometimes before the tool has even been removed from its packaging.
- Plating provides a degree of protection, but it eventually nicks, flakes or wears off, and allows water to seep in.
- Some manufacturers simply dip tools in oil. Once wiped off, tools are left with no protection whatsoever.

Competitor's tools lack the consistent smooth surfaces and sharp corners of Bondhus tools, so moisture can easily accumulate and accelerate the spread of corrosion in competitor tools.

## 12) Color coded handles (screwdrivers, folding tools and T-Handles) & cases (for hex, ball and Star sets)

Color coding of T-Handle and screwdriver handles and Bondhex™ cases makes inch, metric and Star tools easy to identify and distinguish from one another.

Inch	-	yellow
Metric	-	red
Star	-	green

## 13) Bondhex™ case (for ball end, hex and Star key sets)

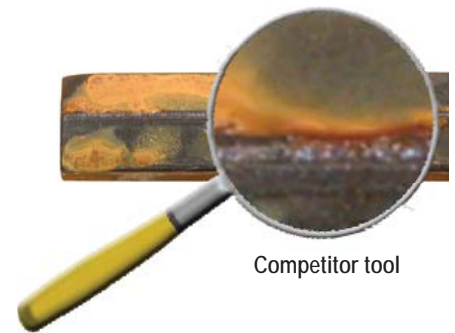
Bondhus ball end, hex and Star key sets are packed in a color coded Bondhex™ case to keep tools neat and sorted. A simple 60 degree turn locks keys in place to eliminate loose, spilled and lost keys. Tool sizes are clearly printed beneath each tool for quick size selection. A Bondhex™ case can also be used with a hex key to increase grip and comfortably generate additional torque.

## 14) Lifetime warranty

Bondhus manufactures the highest quality hex and Star tools available, and every tool is backed by an unconditional lifetime warranty.

*"All Bondhus products are guaranteed for life. If you are not satisfied with a Bondhus tool - for any reason - simply return it. A replacement will be shipped right out at no cost - no hassles, no questions asked."*

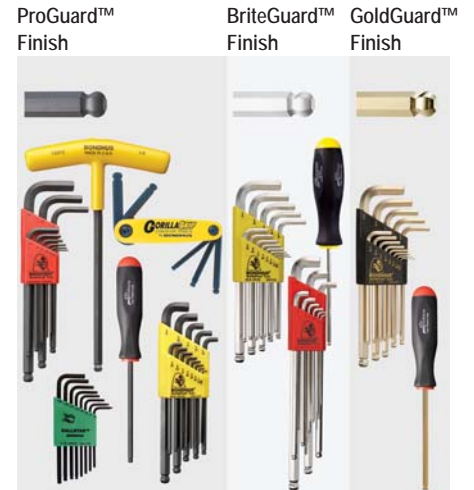
A warranty is only as good as the company standing behind it. Bondhus has been the leading innovator in the hex and Star tool industry for over forty years.



# Ball End Tools

## 15) ProGuard™ (black), BriteGuard™ (chrome) and GoldGuard™ (14k gold) finishes

Bondhus offers tool users the choice of three different types of corrosion protection. ProGuard™ protection is the most effective solution available, and is available on all Bondhus tools. For tool users who prefer a plated finish, BriteGuard™ protection provides a traditional chrome finish and GoldGuard™ protection provides a genuine 14 karat gold finish.



# Ball End Tools

## Frequently Asked Questions

### *What is the purpose of the ball on ball end tools?*

Access and time-savings are the two primary reasons Bondhus invented the Balldriver® ball end. A straight hex tool can only enter a screw head from a straight-on direction. A Bondhus ball end though, can enter from up to a 25 degree angle, providing easy access to screws that cannot be inserted or removed with the straight-on limitation of a hex tip. Reaching screws that would otherwise require disassembly of equipment to gain access to the screws becomes quick and easy. This is especially true when working in blind or difficult to reach locations.

A Bondhus ball end also saves time because it provides quicker and easier entry into a screw head than what a hex tip would. When working near an obstruction that would require removing, repositioning and re-inserting a hex tip tool, a ball end again saves time. The ball end tool can be positioned at an angle to the screw head, to avoid the obstruction, and the tool can be rotated continuously, with no need to remove it with every revolution of the tool.

### *What is the difference between a competitor ball end tool and a Bondhus Balldriver® tool?*

Bondhus is the inventor of the ball end, and the Balldriver® name is the registered trademark belonging only to Bondhus. The term "ball end" is simply a generic name. Although many competitors sell "ball end" tools, they are inferior to the Bondhus Balldriver® brand of ball end tools.

Bondhus ball ends are precisely machined to ensure maximum strength and can always be used at up to a 25 degree angle.

### *Are ball end tips as strong as standard hex tips?*

Every ball end tool has a "neck" which is smaller in diameter than the tip size, so it cannot have quite as much strength as a straight hex tip. However, all Bondhus ball ends have the advantage of being manufactured from Protanium® Steel, which is up to 20% stronger than the standard grades of steel used by competitors.

### *Why do Bondhus ball ends have a 25 degree working angle instead of the lesser or greater working angle of some competitors?*

Through extensive testing, Bondhus has determined that 25 degrees provides the optimal combination of strength and working angle. Competitor tools with greater than 25 degrees of working angle sacrifice strength and are too weak to perform many common applications without breakage. Competitor tools with less than 25 degrees of working angle are somewhat stronger, but sacrifice too much working angle, and the whole purpose of a ball end tool (saving time) is defeated.

# Ball End Tools

## *Why is there a ball end on the long arm of a hex key but not on the short arm?*

The short arm of a hex key has a straight hex tip meant for high torque work such as breaking screws loose. Once a screw is turning freely, the ball end on the long arm can be used to quickly remove the screw.

## *Is a Bondhus ball end tip as strong as an Allen brand ball end tip?*

Allen ball ends are promoted as having a 25 degree working angle and greater strength than competitor tips. Actual testing on Allen brand tools, however, shows large inconsistencies in actual working angle. Angles ranging from as little as 5 degrees to as much as 35 degrees have been measured and documented. Tips with less than 25 degrees of working angle have progressively better strength, but correspondingly poorer angle, and tips with more than 25 degrees of working angle have progressively better working angle but correspondingly poorer strength. An Allen ball end tip with exactly 25 degrees of working angle is not as strong as a Bondhus ball end because Protanium® Steel has greater strength than the 8650 steel used in the manufacturing of Allen brand tools.



4

# Folding Tools

The GorillaGrip® folding tool was designed and developed to be the strongest, easiest to use and most comfortable folding tool set in the world. Functional comparisons and strength tests between GorillaGrip® folding tools and competitor folding tools from around the world, prove all the claims of GorillaGrip® tool superiority. The tools in all GorillaGrip® sets are manufactured with Bondhus' exclusive Protanium® Steel and finished with its' proprietary ProGuard™ corrosion resistant finish. GorillaGrip® folding tool sets save the tool user time every time they are used. GorillaGrip® folding tool sets are protected by six US and foreign patents, ensuring GorillaGrip® features and strength are only available from Bondhus. GorillaGrip® folding tool sets are available in more than twenty five handle and blade, set combinations, the widest range of options in the world.



## Features

- 1) World's strongest handle
- 2) Tools open from both sides
- 3) Molded-in 90 degree stop
- 4) Patented spacers between tools
- 5) Flip-and-Turn feature
- 6) Speed-Wrench feature
- 7) Smooth edges & radiused corners
- 8) Recessed bolt and nut heads
- 9) Molded-in tool size indicators
- 10) Tool ramps
- 11) Compact design
- 12) Custom bolt and lock nut
- 13) Smooth, non-porous handle
- 14) Six US & foreign patents
- 15) Ball ends insert into screws at an angle (ball end tools)
- 16) Tools available for very small sizes:  
As small as .050" & 1.5mm (hex)  
As small as T6 (Star)
- 17) Tools work at a 25 degree angle (ball end tools)
- 18) Superior ball end strength and working angle (ball end tools)
- 19) Funnel insertion (ball end tools)

## Benefits

- 1) Tool user can deliver more torque without breaking handle
- 2) Saves time because tools are selected without folding one layer over the other
- 3) Solid 90 degree stop prevents pinching of hand
- 4) Saves time because individual tools can be selected and tools won't rust because they don't rub against each other
- 5) Saves time by eliminating the need to reposition the tool after each rotation
- 6) Saves time by using handle as a crank in its 'Z' position
- 7) Handle is comfortable to carry and use
- 8) No protruding bolts and nuts to injure the tool user
- 9) Saves time because the size I.D. is at the tip of each tool
- 10) Saves time because tool tips are held in position for easy selection
- 11) Easy to store and carry, easy to deliver more torque
- 12) Tool lasts longer because nut and bolt is stronger than commercial fasteners and the locknut allows end user to adjust the tension of the tools
- 13) Saves time because clean up is easy; Just a quick wipe
- 14) Means this high quality tool can only be supplied by Bondhus
- 15) Saves time because tool user can reach and turn screws that cannot be reached straight-in
- 16) Bondhus' extremely precise manufacturing methods create tools that work very well, even in very small sizes
- 17) Screws can be turned continuously, without constantly taking the tool out of the screw, repositioning it and reinserting it, even at angles up to 25 degrees.
- 18) Bondhus ball end tips are designed to be the perfect balance between angle and strength. Ball end strength is maximized, while still providing a consistent full 25 degrees of working angle.
- 19) Saves time because Bondhus ball ends automatically funnel themselves into the screw head and quickly seat to full depth

5

# Folding Tools

## Features

- 20) Chamfered tool tips
- 21) Precise machining
- 22) Worlds strongest tools - Protanium® Steel
- 23) Worlds best corrosion protection - ProGuard™ Dry Surface Technology
- 24) Color coded handles
- 25) Lifetime warranty

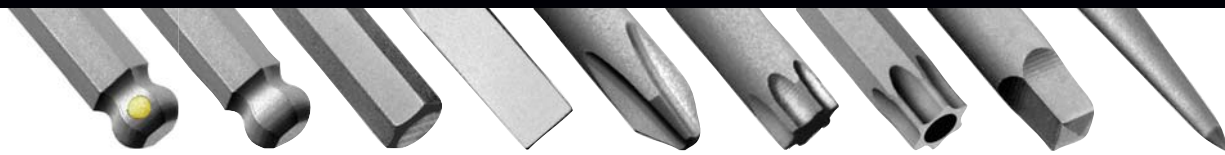
## Benefits

- 20) Saves time because burrs that might prevent insertion of the tool tip into the screw head are completely removed, so tip insertion is quick and easy. Tool tip seats to full depth in screw head.
- 21) Saves time because precision machining means every Bondhus tool fits precisely into the screw head, minimizing breakage and stripping
- 22) Saves time because Bondhus' exclusive Protanium® Steel makes Bondhus tools up to 20% stronger than competitor tools and allows the tool user to deliver more torque without breaking the tool or damaging the screw head.
- 23) Saves time because the tool user does not have to work with rusty tools. ProGuard™ protection delivers up to 5 times the corrosion resistance of any other hex or Star tool finish.
- 24) Saves time because the tool user can quickly identify inch (yellow), metric (red) and Star (green) tools
- 25) Bondhus stands behind every sale with a "No questions asked" lifetime replacement policy

\* Bondhus, Bondhex, ProGuard, Protanium, Balldriver, BallStar, GorillaGrip, BriteGuard and GoldGuard are trademarks of Bondhus Corporation.



# Folding Tools



## 1) Worlds strongest handle

A cantilever is a design with a projecting structure that is supported on only one end. It's function is to carry a load along its length and concentrate that load on the single supporting end. The GorillaGrip® handle was specifically designed to accomplish that very task. Stress applied by radial torque and downward pressure on the handle are 'cantilevered' down the length of the handle, and concentrated at the tip of the tool.

A folding tool handle needs to deliver the required torque without bending or shattering. The GorillaGrip® tool is engineered to deliver strength through its molded one-piece thermoplastic handle. Some competitor handles *look* similar to the shape of a GorillaGrip® handle, but are molded in two or three pieces, making them up to 50% weaker than a GorillaGrip® handle.

Steel handles lack the comfort and features of a GorillaGrip® tool. The GorillaGrip® handle is up to 40% stronger than a steel handle of comparable size, and up to 70% stronger than some plastic handles. It can easily generate 900 inch pounds (102 Nm) with no danger of breaking the handle, and continue to operate smoothly.

In the test shown below, a GorillaGrip® fold up and three competitor tools were tested to determine the torque each handle was capable of generating. All three competitor handles broke at considerably lower torque than the GorillaGrip® handle.



A crane and a GorillaGrip® tool are both examples of a cantilever design

5

Bondhus



Brand 1



Brand 2



Brand 3



Bondhus		900 in-lb (102 Nm)
Brand 1		635 in-lb (72 Nm)
Brand 2		590 in-lb (67 Nm)
Brand 3		520 in-lb (59 Nm)



# Folding Tools

## 2) Tools open from both sides

**Bondhus:** Accessing any single tool should be quick and easy. A GorillaGrip® handle provides blade access from the top and bottom, so time consuming unstacking of blades is eliminated.



**Competitors:** Unstacking and re-stacking blades is frustrating and time-consuming. Folding tools providing tool access from only one side make single blade access difficult.



1) First layer is folded out of the way.



2) Desired tool is lifted. Entire stack often lifts with it.



3) Unwanted tools are folded down.



4) First layer stack is folded back down.

## 3) Molded-in 90 degree stop

**Bondhus:** A GorillaGrip® handle has a molded-in 90° stop, allowing the tool user to push down on the handle when applying torque. The positive stop prevents the handle from collapsing down against the blade and pinching the hand.



**Competitors:** Most competitor tools can only open to 180°, so they lack positive blade stops. In a 90° position, the handle easily collapses down and pinches the users hand.



## 4) Patented spacers between tools

**Bondhus:** Patented, molded in flutes keep tools separated for smooth operation and selection of just one tool at a time.



**Competitors:** Tools that rub against one another or metal spacers, when opened or closed, accelerate rusting and do not operate smoothly. Selecting a tool often lifts multiple blades simultaneously.



Binding, rubbing blades expedite rust



# Folding Tools

## 5) Flip-and-Turn feature

**Bondhus:** Working against an obstruction is no problem for a GorillaGrip® handle. The unique time saving Flip-and-Turn feature eliminates constant removal and repositioning of the tool. Most competitor tools lack this feature.



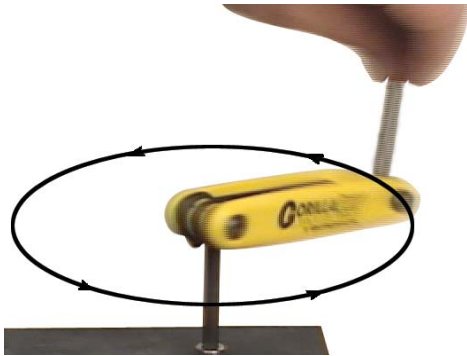
competitor tools lack this feature.

**Competitors:** Blades that can only be opened 180 degrees are incapable of performing the Flip-and-Turn operations of a Bondhus GorillaGrip® tool.



## 6) Speed-wrench feature

**Bondhus:** The 90° positive blade stops enable a GorillaGrip® tool to function as a time saving speed-wrench. Most competitor folding tools can not perform this function.



perform this function.

**Competitors:** Blades that can only be opened 180 degrees cannot be used in a speed-wrench mode.



## 7) Smooth edges & radiused corners

**Bondhus:** The molded GorillaGrip® handle features smooth edges and radiused corners. It is comfortable in the hand, as well as in a pocket.

Smooth Edges



**Competitors:** The sharp edges on many folding tools can actually cut the user.

Sharp edges and protruding screws

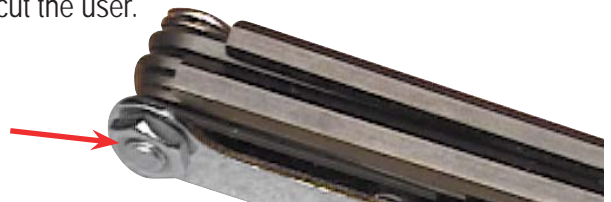


## 8) Recessed bolts & nut heads

**Bondhus:** Screw heads and nuts are recessed into the handle for smooth, comfortable surfaces.



**Competitors:** Many competitor handles have protruding screws and nuts. They are uncomfortable and can cut the user.



# Folding Tools

## 9) Molded in tool size indicators

**Bondhus:** Tool size indicators are molded into the handle at the tip of each tool, making it easy to identify the needed tool.

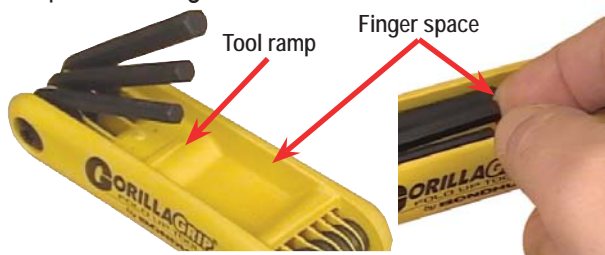


**Competitors:** Most folding tools lack size indicators, making it slow and cumbersome to identify blade sizes.



## 10) Tool ramps

**Bondhus:** Tool ramps keep tools lying flat, and neatly in position. The elevated blades provide space for quick one finger access.



**Competitors:** Many folding tools provide no finger space beneath blades for quick and easy lifting.



## 11) Compact design

**Bondhus:** The compact design of the GorillaGrip® handle means it stores easily in a pocket, and allows the user's hand to fully close around the handle. A closed hand facilitates application of maximum force and control.



**Competitors:** Competitor tools are often overly large, making the tool awkward to carry in a pocket. More importantly, broad handles hold the users' hand open during use. When the hand is open, control and the application of force are reduced.



## 12) Custom bolt and lock nut

**Bondhus:** Custom machined bolts and lock nuts at each end of the handle are stronger than commercially available fasteners and allow the tool user to adjust the holding tension on the tools. This tension feature is infinitely adjustable, keeps tool tension where it is set, and is guaranteed to last a lifetime. Frequent re-tensioning is eliminated.



**Competitors:** Most competitor handles use a standard nut and bolt and a drop of thread lock. Once the nut is turned one time, it will forever be loose. The locking function is lost, and the need for constant re-tensioning is the result. Some designs even require two wrenches to perform re-tensioning.



# Folding Tools

## 13) Smooth, non-porous handle

**Bondhus:** The smooth, non-porous surfaces of the GorillaGrip® handle provide a good non-slip grip, and make clean up a simple task.



**Competitors:** Many competitor handles have rough or porous surfaces, which do not clean up easily, or they have plated surfaces which scratch, chip, flake and rust.



## 14) Six US & foreign patents

Four US and two foreign patents protect the design of the GorillaGrip® handle. Competitors who attempt to copy the shape have to make significant strength trade-offs to make a handle that does not infringe one of these patents. Bondhus aggressively prosecutes infringers and has stopped all competitors that have infringed any of these patents.

## 15) Ball ends insert into screws at an angle

Bondhus ball end tools are tremendous times savers. A hex tool can only be inserted in a screw head from a straight-on direction (0 degrees), but a Bondhus ball end can enter from any angle up to 25 degrees, and insertion is quick and easy. The need to disassemble equipment, to provide tool access to a screw head, can be reduced or eliminated.



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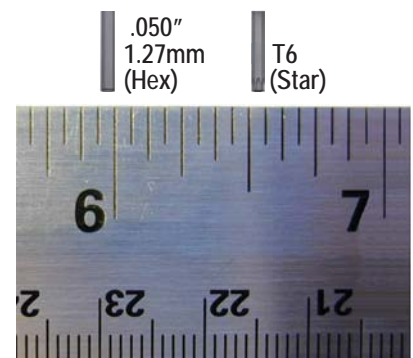
## 16) Tools available for very small sizes:

*As small as .050" & 1.27mm*

*As small as T6*

Bondhus manufactures a broad selection of ball end hex and ball end Star tools for precision applications. Even in these incredibly small sizes, Bondhus tools maintain tight tolerances, highly precise machining and absolute consistency.

Bondhus precision machined tools will not strip fasteners, wear prematurely or damage delicate equipment to which repairs would be expensive and time consuming. Tool users can feel confident that Bondhus tools have the strength and precision to protect even their most delicate and expensive components.



# Folding Tools

## 17) Tools work at up to a 25 degree angle (ball end tools)

Working with a hex tool, near obstructions that block 360 degrees of handle rotation can consume a significant amount of time. A tool must be removed and reinserted with every rotation of the screw, and often, screws can only be turned a fraction of a rotation at a time.



Hex tool constantly removed and re-inserted

**Bondhus:** When using a Bondhus ball end tool, the time and effort of working in those difficult blind or hard to reach locations is greatly reduced. A Bondhus ball end can provide continuous rotation, eliminating the time-consuming need to constantly remove and reinsert the tool.

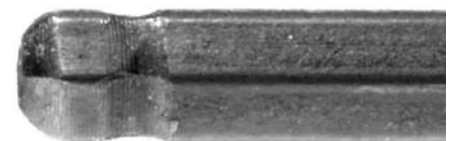


Ball end tool provides continuous rotation

Angle insertion of a screw requires a sensitive feel to know when the thread has been started straight. This is especially important when working with small screw sizes, or inserting screws into soft materials like aluminum or plastic, which are prone to cross-threading. Bondhus ball ends minimize the possibility of cross-threading by providing a full 360 degrees of smooth rotation and preserving rotational sensitivity.



**Competitors:** An imprecisely machined ball end can deliver reduced working angle and can sacrifice smooth rotation, and in turn, not provide the sensitive feel necessary for starting a thread straight. Cross-threading can easily occur, and re-tapping a thread in a difficult location often requires time-consuming disassembly of equipment.



Competitor tool: Imprecise machining sacrifices smooth rotation

Some ball ends are not only poorly machined, they are also undersized. They can rotate smoothly only because of excessive clearance between the tip and socket walls, and give a misleading feel of precision. In just a short time, they will wear excessively, and stripping of the ball end or screw head will be the outcome.



Competitor tool: Imprecise machining causes undersized tips

# Folding Tools

## 18) Superior ball end strength and working angle

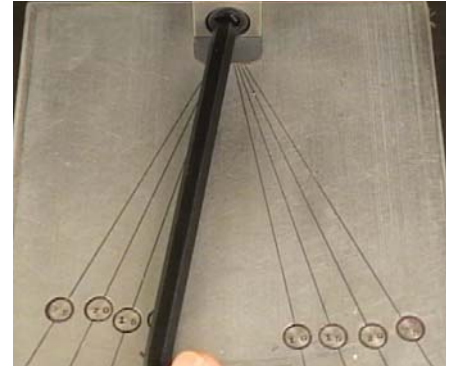
"Working angle" is the maximum angle at which a ball end can operate smoothly, while fully seated in the screw head. A quality ball end tool must provide good working angle without compromising neck strength. Bondhus ball end tools are designed to deliver a full 25 degrees of working angle, while delivering maximum neck strength.

**Competitors:** Competitors manufacture ball ends from common grades of steel that lack the strength of Bondhus Protanium® Steel. To compensate for inadequate strength, some manufacturers *increase* neck size. As neck size increases, however, working angle *decreases*. Strength is improved, but working angle becomes inadequate.

To achieve working angles up to 35°, some manufacturers *reduce* neck size. Reduced neck size decreases strength, and as the recommended seating torque for the screw is approached, the risk of breakage increases. A broken tip can mean a substantial loss of time if the broken ball end jams itself in the screw head or damages the screw head.

**Bondhus:** Bondhus ball end tools achieve the ideal balance between working angle and strength. The strength of Protanium® Steel allows a neck size that delivers a full 25 degrees of working angle, while maintaining superior strength and wear resistance.

A blade with a hex tip begins to yield when maximum torque is reached. The tool user can easily feel that yield, and by not applying additional torque, breakage can be avoided. In contrast, a ball end tip provides no warning of impending breakage to the tool user. When over-torqued, it breaks without warning. This is one of the reasons why the strength of a Protanium® Steel ball end is such an important feature.

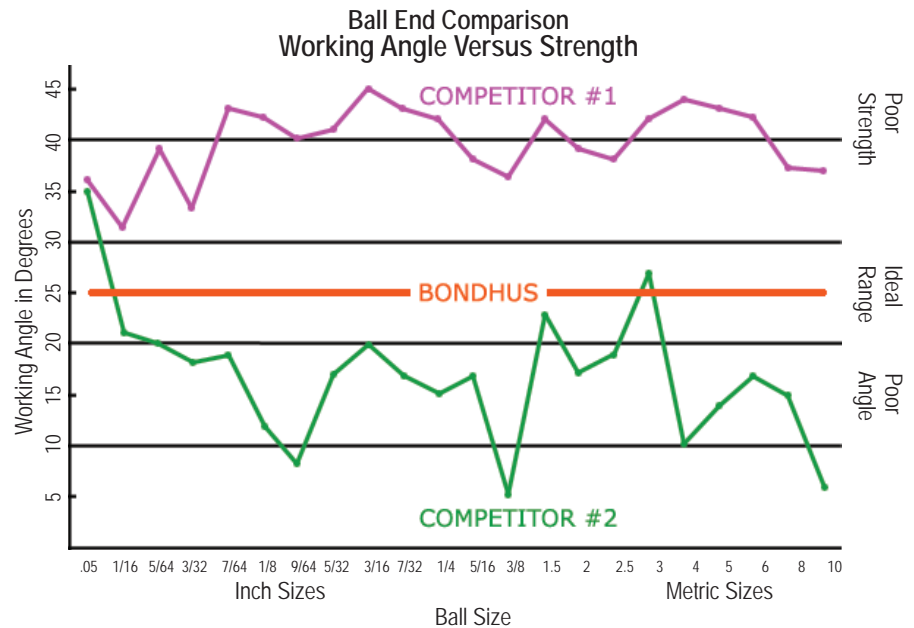


Competitor tool: Thick neck limits working angle to only 9°



Competitor tool: Thin neck size risks breakage

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## 19) Funnel insertion

Bondhus ball ends insert smoothly and are faster and easier to insert into a screw head than a hex tip. The concept by which the ball end channels itself into a screw head is known as funnel insertion. Precise design and machining ensure that the sides of the ball funnel the tip into the screw head and seat to full depth.



# Folding Tools

## 20) Chamfered tool tips

**Bondhus:** Bondhus uses a precise method of cutting, and then chamfers tips to eliminate any possibility of burrs. The chamfering makes insertion of a straight hex or Star tip into a screw head much easier. Bondhus employs several styles of chamfers, using each style where it is most effective. The type of chamfer used is not critical. The point is to ensure burrs are removed from all hex and Star keys. Bondhus hex and Star tips always insert smoothly and seat to full depth for optimal torque and longer tool life.

**Competitors:** Imprecise methods of cutting produce burrs on the tips of hex and Star keys. It is common for burrs to be so large, they need to be filed away before the tool will insert into a screw head.

The clearance between a hex key and the screw walls is typically .0005" (.0127mm) or less on each side of the key, and even a very small burr can interfere with or prevent insertion. If the socket of a screw head is on the small side of its tolerance, and the hex key is on the large side of its tolerance, any amount of burr will prevent proper insertion of the tip into the screw head.

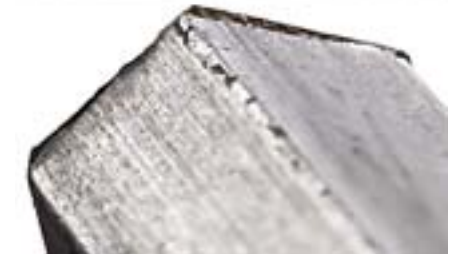
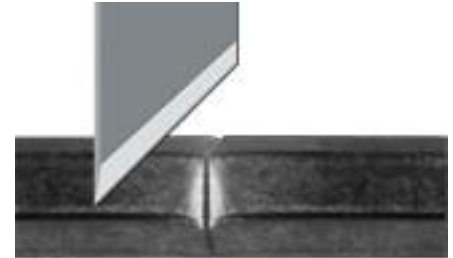
Competitor tools often feel snug in a screw head when first used, and then feel loose after only a couple of uses. The reason this happens is their tips often contain burrs. The burrs make the tool initially feel snug, but as soon as they wear off, the tips loose fit becomes obvious, and it proceeds to wear both the tool tip and the screw head quickly.

An imprecise cutting process can also distort the tool tip, causing it to be undersized, and to be slightly bent. Even chamfering or filing will not correct a problem of this severity.

As a last consideration, the cutting process can produce what is known as lips on the tip of a tool. Protrusions of this nature will prevent the tip from seating to the full depth in the screw head, thus increasing wear and the potential for stripping both the tool and the screw head.



Chamfered Bondhus tip



Competitor: Imprecise cutting causes burrs on tips



Competitor: Tip bent by cutting process



Competitor: Tip with lips will not seat to full depth



# Folding Tools

## 21) Precise machining

**Bondhus:** Professional tool users recognize the Bondhus name as synonymous with quality, consistency and reliability. Bondhus is meticulous about quality and the enforcement of the tightest specifications in the hex and Star tool industry. Every tool Bondhus manufactures is subject to its own set of specifications and a company policy of no exceptions or deviations. Specifications are enforced by quality assurance testing at every stage of the manufacturing process.

Precision machining is critical for a ball end tool to function optimally. Understandably, the smaller a ball end tip is, the more complex the task of machining becomes.

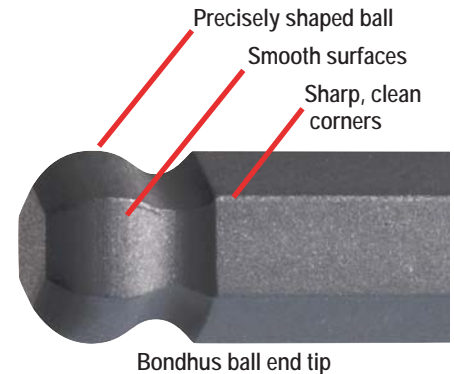
Bondhus maintains incredibly tight tolerances and close clearances between ball end tips and the screw head walls. Bondhus machining accurately maintains the precise geometric shape of the ball on all six sides. Surfaces are smooth, and corners are sharp and clean, even on a tool as small as .050" (1.27mm).

Precise machining results in Bondhus ball end tips having more surface area contacting the screw walls than any other competitor. Bondhus ball end tools far outwear the competition, and dramatically reduce stripping. Fastener wear is also greatly reduced.

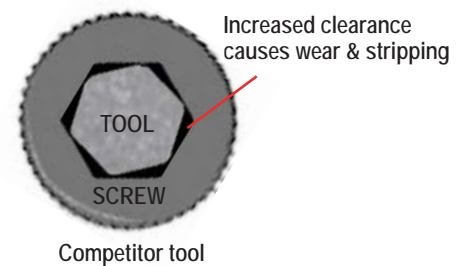
**Competitors:** Claims of quality and precision are also made by competitors who often represent their tools as "comparable", "nearly comparable" or "good enough" when compared to Bondhus tools. Bondhus encourages head-to-head comparison and is pleased to provide all the information necessary for professional tool users to make their own informed decisions.

The ball end to the right is so poorly machined, it cannot even hold a screw in a horizontal position. Working in a blind or difficult location would be nearly impossible with this poorly machined tool tip.

Poorly machined ball ends do not just compromise working angle. Imprecise machining can cause tips to be under-sized and not symmetrical. The clearance between the tip and screw walls increases, causing excessive wear and stripping.



Competitor tool



# Folding Tools

## 22) Worlds strongest tools -Protanium® Steel

### ► Protanium® High Torque Steel - a custom blended steel

Protanium® Steel is much more than “just steel” and much more than a “name”. It is a commitment to producing a level of tool performance unmatched by any competitor. Protanium® High Torque Steel is not an 8650 grade of steel, it is not a form of S-2 and it is not a chrome-vanadium or chrome-moly type of steel. Protanium® High Torque Steel is custom mixed to a formula that is the result of many years of research and continuous development efforts. Bondhus’ customized heat treating processes are the key to bringing out the superior strength properties of Protanium® High Torque Steel. Attaining results that push beyond the accepted limits of performance requires the skill and years of research and development that Bondhus alone has committed itself to.

(For more in-depth information on Protanium® Steel, please refer to Section 1 on pages 1 - 16.)

### Custom blended steel versus common grades of steel

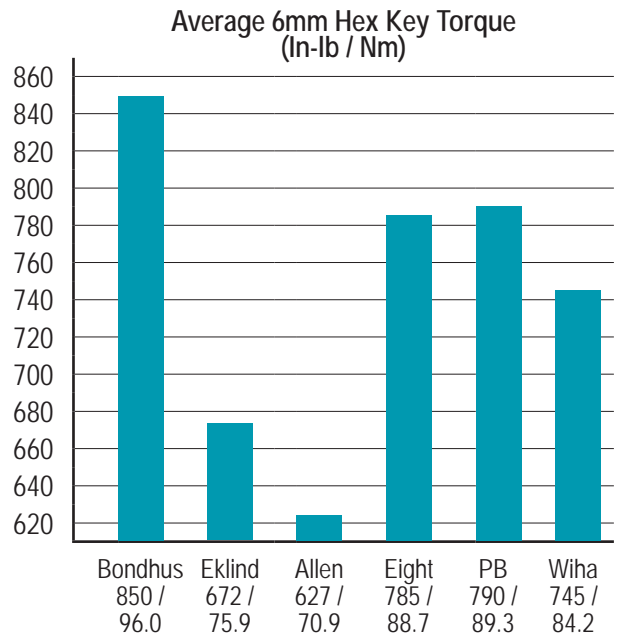
In the broadest possible terms, only two categories of steel are used in the manufacturing of hex and Star tools; custom blended steel and standard grades of steel. A simple comparison makes it easy to see why Bondhus custom blended Protanium® Steel achieves far greater levels of performance than standard grades of steel:

Custom blended Protanium® Steel	Standard grades of steel
A custom blend specifically designed for the rigors and requirements of hex and Star tools	Standard grades of steel are a one-size-fits-all solution, designed for a range of uses, not just hex and Star tools
The elements making up the steel's composition and the process used to produce the steel are customized to the Protanium® Steel specification, enabling use of customized heat treating processes that produce tools with greater hardness and ductility	The tool manufacturer has no control over the steel's blend. Heat treating cannot be customized beyond the limitations of the standard blend
Imperfections are eliminated through the addition of specific elements and by controlling the methods by which mills produce the steel	Tool manufacturer has no control over the steel's production or imperfections that may result
Meticulous quality control, monitoring and documentation are enforced by the Protanium® Steel specification	Steel mills perform their own “standard” quality control
The drawing process is controlled to produce stock with highly precise dimensional accuracy, sharp corners and smooth clean surfaces	Tool manufacturer has little control over drawing process

# Folding Tools

Except for Bondhus, all other hex and Star tool manufacturers use various standard grades of steel in the manufacturing of their tools:

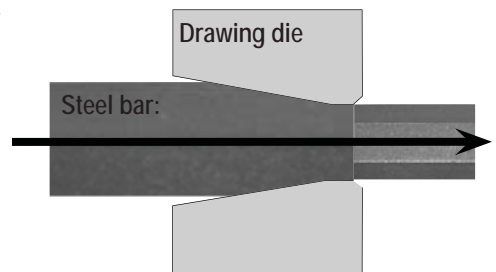
- 8650 is the most common grade in use throughout the U.S. and Asia. It does not achieve the hardness or ductility levels of Protanium® steel.
- Chrome Vanadium is comparable in performance to 8650. It is used primarily in Europe.
- Chrome Moly is similar to Chrome Vanadium, but is somewhat stronger and harder. Because it is fairly expensive, manufacturers generally only use it on their higher priced tools like ball end products, and substitute lower grades for their hex and folding tools. Europe and Japan are the primary users.
- S2 is used by only a small number of manufacturers. It is harder than 8650, but it is also less ductile, more costly, and far more prone to shattering.
- Carbon steel grades, such as 1050, are low-grade steels that are inferior to those listed above. They are still used by some manufacturers in Europe and Asia.



## ► *Bondhus controlled steel drawing process*

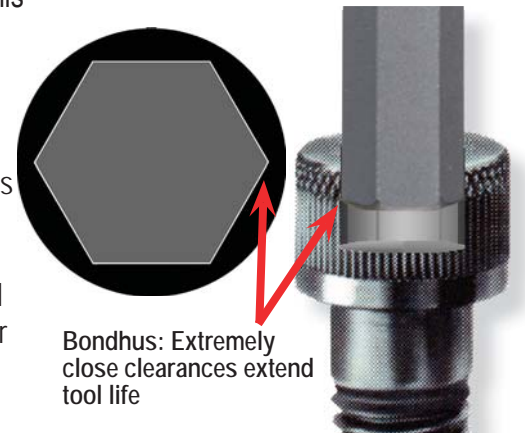
Changing the size or shape of a metal bar or rod by pulling it through a die is known as drawing. It is a critical process in the production of high quality steel, since it determines the dimensional precision and surface quality of the steel.

Standard grades of steel are drawn to tolerances that do not conform to the Protanium® Steel specification for precision, so Bondhus exercises full control over the drawing process. Bondhus works closely with its' steel suppliers to ensure 100% compliance with the Protanium® Steel drawing specification, and will not work with any mill unwilling to make this commitment.



### Close clearances

Tolerances imposed by the Protanium® Steel drawing specification produce stock so precisely drawn that clearances between a Bondhus tool tip and the screw walls is typically one half thousandth of an inch or less. Clearances this close produce tool tips with greater surface area contacting the screw walls. Smaller clearances between the tool surface and the screw head mean Bondhus tools greatly reduce wear of tool tips and screw heads, and reduce or eliminate the potential of stripping.



# Folding Tools

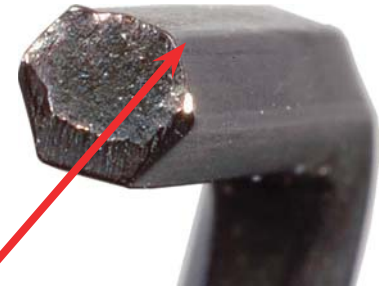
## Sharp corners

Another requirement of the Protanium® Steel drawing specification is that corners be sharp and smooth. Eliminating gaps between the tool tip corners and the screw walls means tool tip surface area increases. Tool tip and screw head wear is greatly reduced, since the primary cause of screw stripping has been eliminated.

Standard grades of steel allow far more rounding of corners during the drawing process and surfaces that are not nearly as smooth, so the process of tool wear and screw stripping is accelerated. Once again, tools made with standard grades of steel perform inconsistently and unreliably.



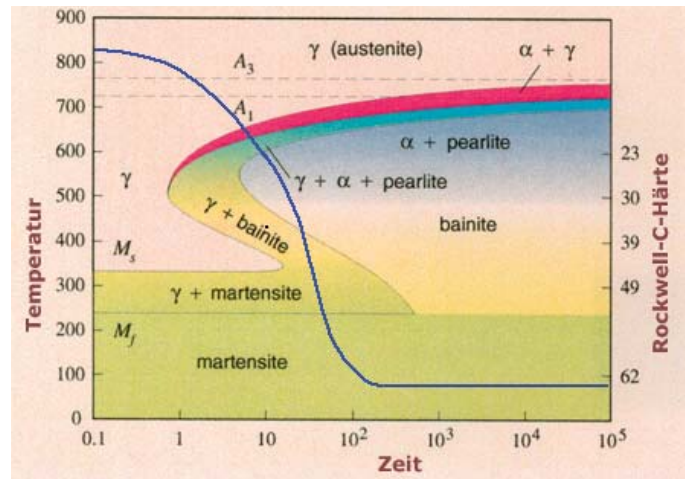
Bondhus: Sharp, clean corners



Competitors: Rounded corners accelerate wear and stripping

## ► Customized heat treating process assures optimal combination of hardness and ductility

Heat treating is a series of processes where steel is heated to a temperature referred to as its *transformation point*, where its atomic structure actually changes. It is then cooled (quenched) in a highly controlled process where it is held at a specific *temperature* for a precise period of *time*. Complex documents known as TTT Charts (Time / Temperature / Transform) show this relationship. They assist in determining an optimal heating and quenching cycle for obtaining desired properties such as optimal microstructure, grain size, hardness and ductility.



Sample TTT chart

## Truly customized heat treating

An essential point to understand about heat treating is that the blend of the steel largely determines how and to what extent desired properties of the steel can be obtained in the heat treating process. In other words, controlling and customizing the blend of the steel is the only means by which truly customized heat treating can be accomplished. Protanium® Steel starts as a custom blended steel, and is transformed into hard, ductile tools by customized heat treat processes.

- Competitors must perform their heat treating to accommodate the limitations of the standard grades of steel they purchase. Since they have no control over the blend of the steel, their heat treating cannot achieve the levels of hardness and ductility achieved by Protanium® Steel.
- Bondhus continually improves the blend of Protanium® Steel to achieve full customization of the heat treating process. With full control of the steel's blend and its heat treating, Protanium® Steel is capable of achieving levels of hardness and ductility well beyond the limitations of the standard grades of steel used by competitors

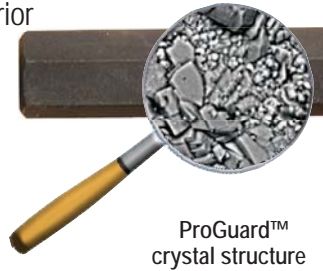


# Folding Tools

## 23) Worlds best corrosion protection - ProGuard™ Dry Surface Technology

### ► ProGuard™ surface is impermeable to moisture and contaminants

ProGuard™ dry surface protection represents a dramatic improvement over traditional methods of protecting hex and Star tools. The ProGuard™ crystal structure provides a superior barrier against elements that cause rust and corrosion. It protects the tool for a lifetime of use and keeps tools looking attractive.



ProGuard™ crystal structure

Independent lab testing has proven ProGuard™ finish is up to five times more effective than alternative finishes offered by competitors.

### ► Finish is dry and clean with a final light coating of oil

**Bondhus:** The ProGuard™ finish locks out moisture and contaminants without the ongoing requirement of an oily surface. ProGuard™ tools receive a light coat of oil prior to packaging, but do not rely on oil as their primary means of protection. Tool user's hands and work areas remain dry and clean.

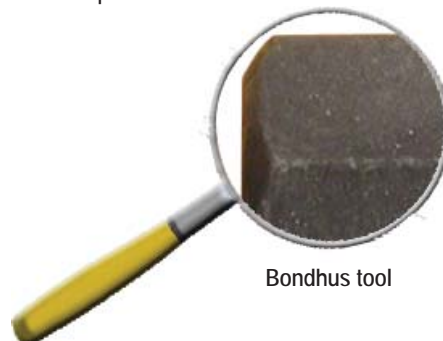
**Competitors:** Tools with inadequate protection rely on the user to keep the surface sealed with oil. Tools are dirty, messy and unpleasant to work with, and corrosion protection still remains inadequate.

### ► ProGuard™ finish is permanently bonded to surface of tool

**Bondhus:** ProGuard™ protection is a proprietary finish only available on Bondhus tools. It provides a permanent finish that cannot be wiped off like a black oxide or oil finish.

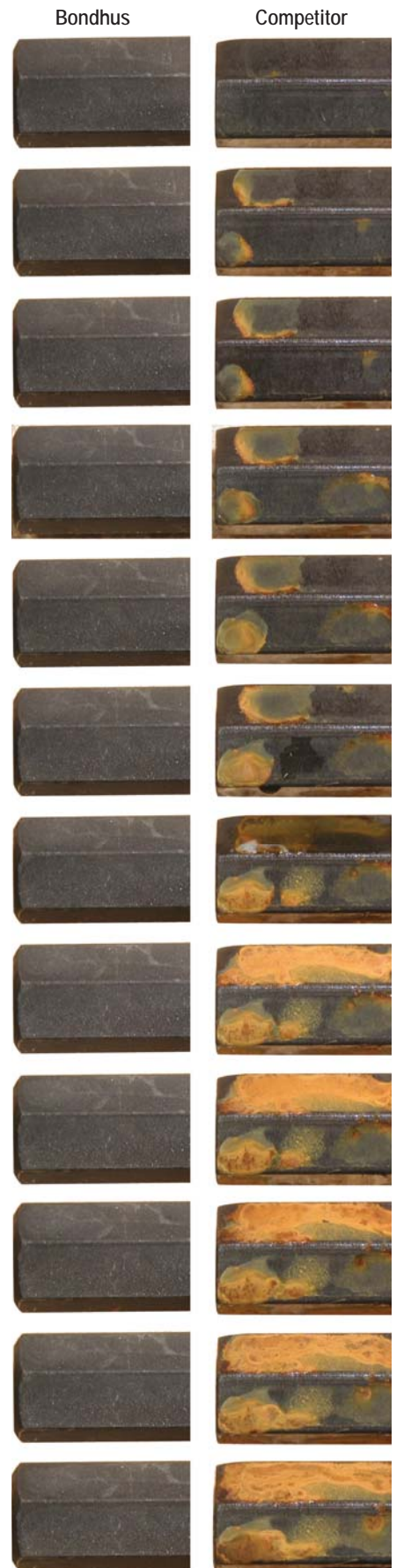
Application of the ProGuard™ finish starts with a thorough caustic cleaning of the tool's surface. A small grained crystal structure is then permanently bonded to the entire surface of the tool through a ten step process. The resulting tight structure makes it very difficult for moisture and contaminants to penetrate the surface.

Smooth surfaces and sharp corners provide further protection to Bondhus tools by denying moisture and contaminants places to collect.



Bondhus tool

## 12 hour time-lapse moisture test sequence

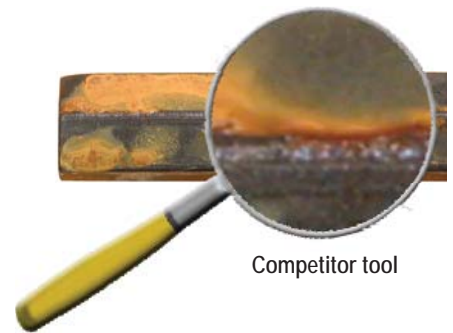


# Folding Tools

► **Competitors:** Three basic finishes are typically used by competitors. Each has associated deficiencies, and none is ideally suited for the professional tool market:

- Black oxide is a coating that forms on the surface of a tool through a chemical reaction with iron. It's commonly used on tools and forgings to create a dark gray or black color, but is both porous and easily wiped off. In spite of the coating of oil normally used on it, corrosion starts forming almost immediately, sometimes before the tool has even been removed from its packaging.
- Plating provides a degree of protection, but it eventually nicks, flakes or wears off, and allows water to seep in.
- Some manufacturers simply dip tools in oil. Once wiped off, tools are left with no protection whatsoever.

Competitor's tools lack the consistent smooth surfaces and sharp corners of Bondhus tools, so moisture can easily accumulate and accelerate the spread of corrosion in competitor tools.



## 24) Color coded handles (screwdrivers, folding tools and T-Handles) & cases (for hex, ball and Star sets)

Color coding of T-Handle and screwdriver handles and Bondhex™ cases makes inch, metric and Star tools easy to identify and distinguish from one another.

Inch	-	yellow
Metric	-	red
Star	-	green
Utility	-	teal
Inch/metric	-	orange



## 25) Lifetime warranty

Bondhus manufactures the highest quality hex and Star tools available, and every tool is backed by an unconditional lifetime warranty.

*"All Bondhus products are guaranteed for life. If you are not satisfied with a Bondhus tool - for any reason - simply return it. A replacement will be shipped right out at no cost - no hassles, no questions asked."*

A warranty is only as good as the company standing behind it. Bondhus has been the leading innovator in the hex and Star tool industry for over forty years.



## Metal Folding Tools

Metal folding tools are still popular with some tool users. Bondhus manufactures both hex and Star tipped metal handle folding tool sets in a range of sizes.

# Folding Tools

## Frequently Asked Questions

### *Is a GorillaGrip® handle as strong as a metal fold up?*

It is considerably stronger. It is designed to be stronger. A GorillaGrip® handle is up to 40% stronger than a steel handle and up to 70% stronger than other types of plastic handles. This design is protected by six US and foreign patents, ensuring the strength of a GorillaGrip® handle is only available from Bondhus

### **Why does Bondhus use custom machined nuts and bolts in the GorillaGrip® handle?**

They are significantly stronger than commercially available nuts and bolts.

### *Why does the GorillaGrip® tool not lock in the screwdriver position?*

The greatest risk of skinning or pinching fingers is when generating torque in the 90 degree handle position to break a screw loose. Folding tools that lock in the screwdriver position do not have the 90 degree stop a GorillaGrip® folding tool has. As a result, when a competitor handle collapses down onto the blade, the users fingers are pinched between the handle and the blade. The GorillaGrip® handle eliminates this pinching possibility when working in the high torque position of 90 degrees.

GorillaGrip® tools also have “turn & flip” and “speed-wrench” features that save significant amounts of time. Folding tools with screwdriver stops at 90 degrees sacrifice both of these useful features.

### *Are the keys in folding tool sets as strong as Bondhus hex keys?*

YES. GorillaGrip® keys are made from the exact same Protanium® Steel as every other Bondhus tool. Bondhus has a strict policy against the deceptive practice many manufacturers use of substituting lower grades of steel in hex key and folding tool set product lines.

### *Are GorillaGrip® tools available with ball end tips?*

YES. GorillaGrip® sets with tip sizes of 3/16 - 3/8” and 5 - 10mm are available with ball end tips. Bondhus does not manufacture the GorillaGrip® tool with ball end tips smaller than 3/16” and 5mm though, because a folding tool handle can easily over torque and break the ball end tips of smaller tool sizes.

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# T-Handle Tools

The Bondhus T-Handle was designed and developed to be strong, easy to use and comfortable. The welded handle and blade joint guarantees a permanent connection. The form-fitting handle design fits the curve of the users hand, increasing comfort and minimizing fatigue. All handles are coated with a smooth, cushioned PVC material which further increases the comfort of the handle during use. The smooth handle surface also speeds cleanup. The handles easily wipe clean. All Bondhus T-Handle tools are manufactured with Bondhus' exclusive Protanium® Steel and finished with its' proprietary ProGuard™ corrosion resistant finish. Bondhus T-Handle tools are available in 6", 9", and graduated lengths and with hex, ball and Star tips - the widest range of options in the world.



## Features

- 1) Solid steel handles
- 2) Welded handle/blade connection
- 3) Ergonomic handle design
- 4) Flywheel effect
- 5) Handle coating extends along blade
- 6) Smooth, non-porous handle coating
- 7) Extra long blades on ballpoint T's
- 8) Assorted blade lengths (6", 9", etc)
- 9) Sizes printed on handles
- 10) Indestructible 3-way stand
- 11) Ball ends insert into screws at an angle
- 12) Tools work at a 25 degree angle (ball end tools)
- 13) Superior ball end strength and working angle (ball end tools)
- 14) Funnel insertion (ball end tools)
- 15) Chamfered tool tips
- 16) Precise machining

## Benefits

- 1) Increased strength and durability
- 2) Increased strength and greater resistance to breakage  
The tool user will never be stabbed in the hand by a blade that has broken free and pushed through the handle
- 3) Increased user comfort, less hand fatigue
- 4) Saves time due to faster insertion and removal of screws
- 5) Eliminates user pain where the fingers close around the handle and sharp edges of the blade would normally rub on the fingers
- 6) Saves time because clean up is easy; Just a quick wipe  
Cushion effect of coating reduces user hand fatigue
- 7) Ease of use for end user. The longer blades allow full use of the 25° ballpoint tip
- 8) Allow user to choose the right length for their task
- 9) Makes selection of the right size tool quick and easy
- 10) Convenience; Tools are organized for easy access. The stand can be mounted in any of three positions and sizes are clearly identified.
- 11) Saves time because tool user can reach and turn screws that cannot be reached straight-in
- 12) Screws can be turned continuously, without constantly taking the tool out of the screw, repositioning it and reinserting it, even at angles up to 25 degrees.
- 13) Bondhus ball end tips are designed to be the perfect balance between angle and strength. Ball end strength is maximized, while still providing a consistent full 25 degrees of working angle.
- 14) Saves time because Bondhus ball ends automatically funnel themselves into the screw head and quickly seat to full depth
- 15) Saves time because burrs that might prevent insertion of the tool tip into the screw head are completely removed, so tip insertion is quick and easy. Tool tip seats to full depth in screw head.
- 16) Saves time because precision machining means every Bondhus tool fits precisely into the screw head, minimizing breakage and stripping



# T-Handle Tools

## Features

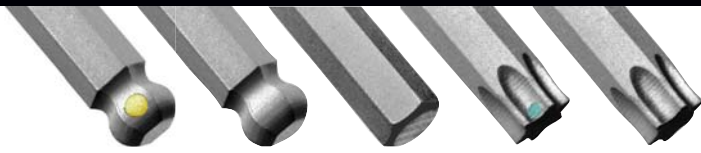
- 17) Consistent 25 degree working angle on ball end tools
- 18) Handles matched to tip torque
- 19) Worlds strongest tools - Protanium® Steel
- 20) Worlds best corrosion protection - ProGuard™ Dry Surface Technology
- 21) Color coded handles (Screwdrivers, folding tools and T-Handles)
- 22) Lifetime warranty

## Benefits

- 17) Saves time because tool users can absolutely count on every Bondhus ball end tool to provide a full 25 degrees of working angle, period.
- 18) Handles are sized to comfortably deliver an appropriate level of torque and assist in preventing damage to ball end tips.
- 19) Saves time because Bondhus' exclusive Protanium® Steel makes Bondhus tools up to 20% stronger than competitor tools and allows the tool user to deliver more torque without breaking the tool or damaging the screw head.
- 20) Saves time because the tool user does not have to work with rusty tools. ProGuard™ protection delivers up to 5 times the corrosion resistance of any other hex or Star tool finish.
- 21) Saves time because the tool user can quickly identify inch (yellow), metric (red) and star (green) tools
- 22) Bondhus stands behind every sale with a "No questions asked" lifetime replacement policy

\* Bondhus, Bondhex, ProGuard, Protanium, Balldriver, BallStar, GorillaGrip, BriteGuard and GoldGuard are trademarks of Bondhus Corporation.

# T-Handle Tools



## 1) Solid steel handles

The handle of a Bondhus T-Handle is constructed of solid steel. Unlike plastic handles, it will not crack, split, or break when maximum torque is applied. The strength of steel allows Bondhus handles to be sized for comfort and functionality, not over-sized to compensate for weaker plastic materials.



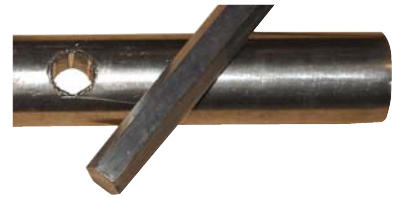
## 2) Welded handle/blade connection

**Bondhus:** Bondhus handles are permanently welded.

There is no chance the blades will ever loosen. The tool user is in no danger of the blade pushing through the top of the handle and stabbing into the palm of the hand.



**Competitors:** The friction fit blades in competitors' T-Handles are not welded. They can loosen, slip, and even fall out or punch through the top of the handle.



## 3) Ergonomic handle design

**Bondhus:** The palm of the hand is not flat, so a Bondhus handle matches the curve of the hand to provide better comfort than older style straight handles. Fatigue is greatly reduced, and when applying torque, the discomfort and pain generated by straight handle designs is eliminated. The curved handle also distributes pressure evenly across the palm of the hand.



**Competitors:** A pistol grip handle does not distribute pressure well, so the short side of the handle digs into the hand. In addition, two-handed operation is not possible.



Loop T-Handles flex and separate when torque is applied, so it is easy to get pinched as the torque is released and the handle comes back together. They can also send a painful shock through the hand when the handle snaps back as a screw breaks loose.



Old style straight handles do not conform to the shape of the hand. As a result, they cannot provide the comfort of a curved Bondhus handle.

## 4) Flywheel effect

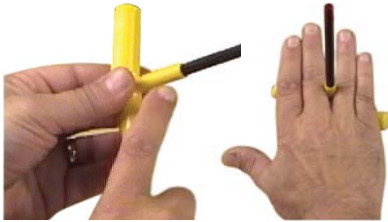
The sheer mass of the Bondhus handle can generate a spinning flywheel effect that can save time inserting or extracting screws. Plastic T-Handles lack the required mass to be used in this manner.



# T-Handle Tools

## 5) Handle coating extends along blade

**Bondhus:** The shank of a Bondhus handle is extended to prevent blisters between the fingers. The shank diameter is also sized for a comfortable fit.



**Competitors:** The shank of a handle like this is long enough, but it is too wide. As soon as torque is applied, it is painful to operate. It also has seams, and a slightly textured surface that can cause blisters between the fingers.



## 6) Smooth non-porous handle coating

**Bondhus:** A Bondhus T-Handle is cushioned to provide both comfort and a positive grip. It has no texture or seams to cause blisters on the hand, or between the fingers where they contact the shank of the handle.

The smooth coating on Bondhus T-Handles will not stain, and will not hold or absorb dirt and contaminants. Cleanup is as quick and easy as wiping with a towel.



**Competitors:** Hard plastic handles are not cushioned. They can quickly produce fatigue and cramping in the hand.

Handles with textured surfaces are difficult and time-consuming to clean. Stained surfaces and embedded grime make tools unattractive and unpleasant to work with.








## 7) Extra long blades on ball end T-Handles

ProHold® tip ball end, and Star T-Handles have extra long blades.

## 8) Assorted blades lengths

Hex T-Handles are available with 6", 9", and graduated length blades.

	T-Handle Lengths	
	3/32 - 3/8	6.1 - 11.8"
	3/32 - 3/8	4.2 - 8.3" (Graduated lengths) 6" (Graduated lengths) 9" (Graduated lengths)
	4 - 10mm	8.7 - 12.1"
	2.0 - 10mm	4 - 9.1" (Graduated lengths) 6" (Graduated lengths) 9" (Graduated lengths)
	T9 - T55	6.1 - 8.6" (Graduated lengths)

## 9) Sizes printed on handles

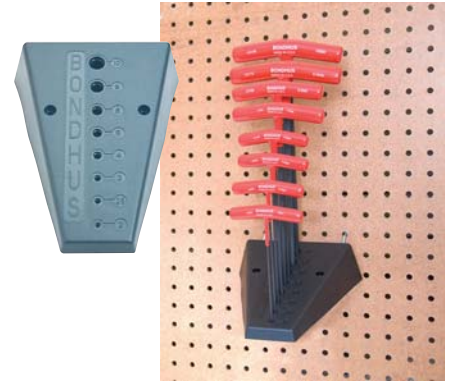
Sizes are printed on all handles to save time selecting the correct tool size.



# T-Handle Tools

## 10) Indestructible 3-way stand

**Bondhus:** The sturdy Bondhus T-Handle stand can be used as a free standing portable unit, or mounted in either of two different orientations. T-Handle sets can be purchased with or without a stand, and the stand can also be purchased separately. Inch, metric, and Star configurations are available, with sizes clearly marked.



## 11) Ball ends insert into screws at an angle

Bondhus ball end tools are tremendous times savers. A hex tool can only be inserted in a screw head from a straight-on direction (0 degrees), but a Bondhus ball end can enter from any angle up to 25 degrees, and insertion is quick and easy. The need to disassemble equipment to provide tool access to a screw head can be reduced or eliminated.



## 12) Tools work at up to a 25 degree angle (ball end tools)

Working with a hex tool, near obstructions that block 360 degrees of handle rotation, can consume significant amounts of time. A standard hex tool must be removed and reinserted with every rotation of the screw, and often, screws can only be turned a fraction of a rotation at a time.



Hex tool constantly removed and re-inserted

**Bondhus:** When using a Bondhus ball end tool, the time and effort of working in those difficult blind or hard to reach locations is greatly reduced. A Bondhus ball end can provide continuous rotation, eliminating the time-consuming need to constantly remove and reinsert the tool.



Ball end tool provides continuous rotation

Angle insertion of a screw requires a sensitive feel to know when the thread has been started straight. This is especially important when working with small screw sizes, or inserting screws into soft materials like aluminum or plastic, which are prone to cross-threading. Bondhus ball ends minimize the possibility of cross-threading by providing a full 360 degrees of smooth rotation and preserving rotational sensitivity.



6

# T-Handle Tools

**Competitors:** An imprecisely machined ball end can deliver reduced working angle and can sacrifice smooth rotation, and in turn, not provide the sensitive feel necessary for starting a thread straight. Cross-threading can easily occur, and re-tapping a thread in a difficult location often requires time-consuming disassembly of equipment.



Competitor tool: Imprecise machining sacrifices smooth rotation

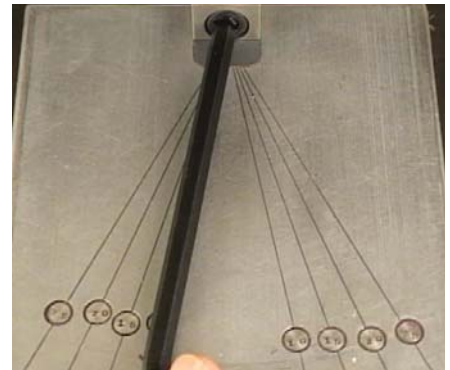
Some ball ends are not only poorly machined, they are also undersized. They can rotate smoothly only because of excessive clearance between the tip and socket walls, and give a misleading feel of precision. In just a short time, they will wear excessively, and stripping of the ball end or screw head will be the outcome.



Competitor tool: Imprecise machining causes undersized tips

### 13) Superior ball end strength and working angle

“Working angle” is the maximum angle at which a ball end can operate smoothly, while fully seated in the screw head. A quality ball end tool must provide good working angle without compromising neck strength. Bondhus ball end tools are designed to deliver a full 25 degrees of working angle, while delivering maximum neck strength.



Competitor tool: Thick neck limits working angle to only 9°

**Competitors:** Competitors manufacture ball ends from common grades of steel that lack the strength of Bondhus Protanium® Steel. To compensate for inadequate strength, some manufacturers *increase* neck size. As neck size increases, however, working angle *decreases*. Strength is improved, but working angle becomes inadequate.

To achieve working angles up to 35°, some manufacturers *reduce* neck size. Reduced neck size decreases strength, and as the recommended seating torque for the screw is approached, the risk of breakage increases. A broken tip can mean a substantial loss of time if the broken ball end jams itself in the screw head or damages the screw head.

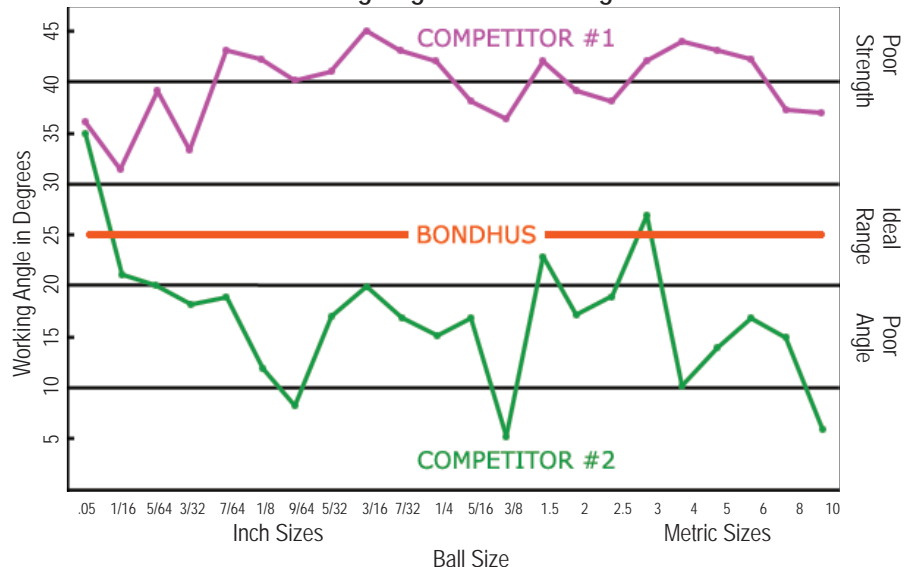


Competitor tool: Thin neck size risks breakage

**Bondhus:** Bondhus ball end tools achieve the ideal balance between working angle and strength. The strength of Protanium® Steel allows a neck size that delivers a full 25 degrees of working angle, while maintaining superior strength and wear resistance.

A blade with a hex tip begins to yield when maximum torque is reached. The tool user can easily feel that yield, and by not applying additional torque, breakage can be avoided. In contrast, a ball end tip provides no warning of impending breakage to the tool user. When over-torqued, it breaks without warning. This is one of the reasons why the strength of a Protanium® Steel ball end is such an important feature.

Ball End Comparison  
Working Angle Versus Strength



# T-Handle Tools

## 14) Funnel insertion

Bondhus ball ends insert smoothly and are faster and easier to insert into a screw head than a hex tip. The concept by which the ball end channels itself into a screw head is known as funnel insertion. Precise design and machining ensure that the sides of the ball funnel the tip into the screw head and seat to full depth.



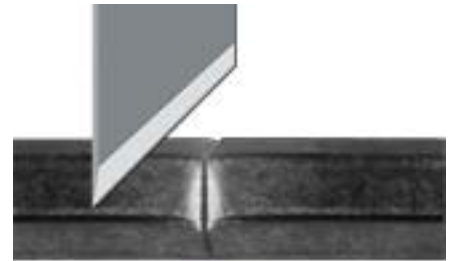
## 15) Chamfered tool tips

**Bondhus:** Bondhus uses a precise method of cutting, and then chamfers tips to eliminate any possibility of burrs. The chamfering makes insertion of a straight hex or Star tip into a screw head much easier. Bondhus employs several styles of chamfers, using each style where it is most effective. The type of chamfer used is not critical. The point is to ensure burrs are removed from all hex and Star keys. Bondhus hex and Star tips always insert smoothly and seat to full depth for optimal torque and longer tool life.



Chamfered Bondhus tip

**Competitors:** Imprecise methods of cutting produce burrs on the tips of hex and Star keys. It is common for burrs to be so large, they need to be filed away before the tool will insert into a screw head.



6

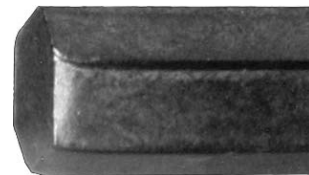
The clearance between a hex key and the screw walls is typically .0005" (.0127mm) or less on each side of the key, and even a very small burr can interfere with or prevent insertion. If the socket of a screw head is on the small side of its tolerance, and the hex key is on the large side of its tolerance, any amount of burr will prevent proper insertion of the tip into the screw head.



Competitor: Imprecise cutting causes burrs on tips

Competitor tools often feel snug in a screw head when first used, and then feel loose after only a couple of uses. The reason this happens is their tips often contain burrs. The burrs make the tool initially feel snug, but as soon as they wear off, the tips loose fit becomes obvious, and it proceeds to wear both the tool tip and the screw head quickly.

An imprecise cutting process can also distort the tool tip, causing it to be undersized, and to be slightly bent. Even chamfering or filing will not correct a problem of this severity.



Competitor: Tip bent by cutting process

As a last consideration, the cutting process can produce what is known as lips on the tip of a tool. Protrusions of this nature will prevent the tip from seating to the full depth in the screw head, thus increasing wear and the potential for stripping both the tool and the screw head.



Competitor: Tip with lips will not seat to full depth

# T-Handle Tools

## 16) Precise machining

**Bondhus:** Professional tool users recognize the Bondhus name as synonymous with quality, consistency and reliability. Bondhus is meticulous about quality and the enforcement of the tightest specifications in the hex and Star tool industry. Every tool Bondhus manufactures is subject to its own set of specifications and a company policy of no exceptions or deviations. Specifications are enforced by quality assurance testing at every stage of the manufacturing process.

Precision machining is critical for a ball end tool to function optimally. Understandably, the smaller a ball end tip is, the more complex the task of machining becomes.

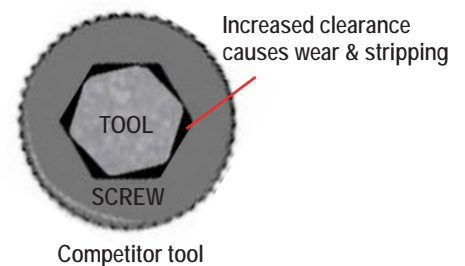
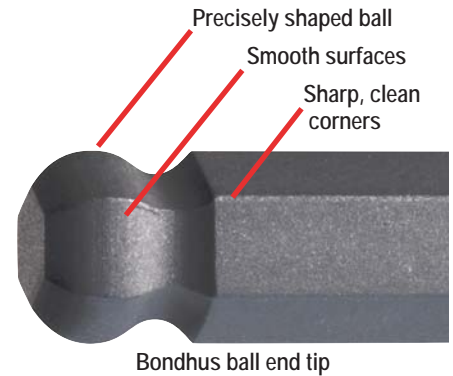
Bondhus maintains incredibly tight tolerances and close clearances between ball end tips and the screw head walls. Bondhus machining accurately maintains the precise geometric shape of the ball on all six sides. Surfaces are smooth, and corners are sharp and clean, even on a tool as small as .050" (1.27mm).

Precise machining results in Bondhus ball end tips having more surface area contacting the screw walls than any other competitor. Bondhus ball end tools far outwear the competition, and dramatically reduce stripping. Fastener wear is also greatly reduced.

**Competitors:** Claims of quality and precision are also made by competitors who often represent their tools as "comparable", "nearly comparable" or "good enough" when compared to Bondhus tools. Bondhus encourages head-to-head comparison and is pleased to provide all the information necessary for professional tool users to make their own informed decisions.

The ball end to the right is so poorly machined, it cannot even hold a screw in a horizontal position. Working in a blind or difficult location would be nearly impossible with this poorly machined tool tip.

Poorly machined ball ends do not just compromise working angle. Imprecise machining can cause tips to be under-sized and not symmetrical. The clearance between the tip and screw walls increases, causing excessive wear and stripping.

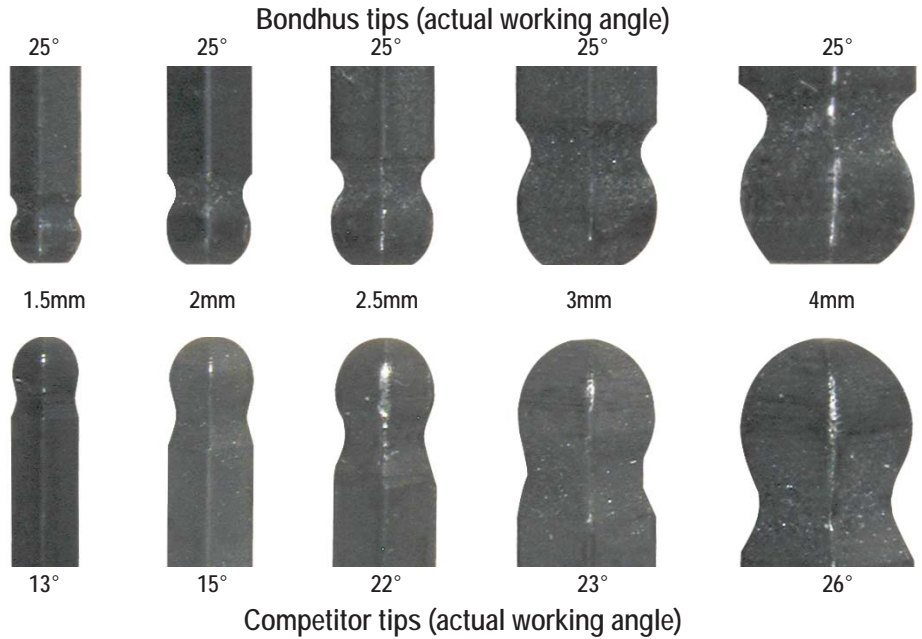


# T-Handle Tools

## 17) Consistent 25 degree working angle on ball end tools

**Bondhus:** Bondhus ball end tips are precisely machined to provide a consistent 25 degrees of working angle, regardless of how large or small the tool is.

**Competitors:** Comparing Bondhus ball ends to those of a well known competitor, the differences are quite dramatic. Wide tolerances and imprecise machining cause many competitor ball ends to have an irregular ball shape. Wide variations in working angle from one tool to the next is the result, with some tools having less than 15° of working angle.



The competitor who manufactures these tools claims a 30° working angle. Actual measurement though, showed large inconsistencies from one tool to the next, and none were capable of reaching 30°.



## 18) Handles matched to tip torque (screwdrivers and T-Handles)

**Bondhus:** A screwdriver is capable of over-torquing its blade and can easily result in damage to the tool. Bondhus is the only manufacturer to design handles matched to the torque capacity of their blades and tips. Whether using a hex, Star or ball end tip, tool users can feel confident that applying torque will not result in breakage or damage to a Bondhus screwdriver.

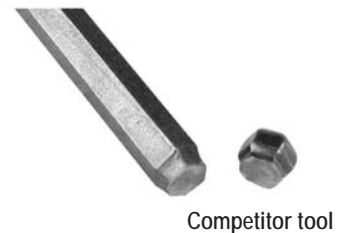


A T-Handle that is too large can easily generate too much torque and risk blade or tip damage. A T-Handle that is too small requires wasted effort to generate required torque, resulting in needless user fatigue. The handles on all Bondhus T-Handles are sized to strike a balance between ease of use and protection against tool damage. Handles are large enough to easily and comfortably generate needed torque, yet small enough to help prevent accidental over-torquing that could damage the blade or tip.

**Competitors:** Many screwdriver and T-Handle tools are available with handles that far exceed the torque capacity of their blades or tips. Damage and breakage, caused by over-torquing, is common to these tools.



A handle this large, is capable of generating more torque than this ball end tip can deliver. Without warning, the tip can easily be broken off.



Bondhus does not manufacture ball end T-Handles in sizes smaller than 5/32" and 4mm. A T-Handle could easily over-torque and break smaller size ball end tips. Hex tips are provided on tools of these sizes, in order to prevent tip damage.

Inch	Metric
3/32"	2mm
7/64"	2.5mm
1/8"	3mm
9/64"	

T-Handles with hex tips



# T-Handle Tools

## 19) Worlds strongest tools -Protanium® Steel

### ► Protanium® High Torque Steel - a custom blended steel

Protanium® Steel is much more than “just steel” and much more than a “name”. It is a commitment to producing a level of tool performance unmatched by any competitor. Protanium® High Torque Steel is not an 8650 grade of steel, it is not a form of S-2 and it is not a chrome-vanadium or chrome-moly type of steel. Protanium® High Torque Steel is custom mixed to a formula that is the result of many years of research and continuous development efforts. Bondhus’ customized heat treating processes are the key to bringing out the superior strength properties of Protanium® High Torque Steel. Attaining results that push beyond the accepted limits of performance requires the skill and years of research and development that Bondhus alone has committed itself to.

(For more in-depth information on Protanium® Steel, please refer to Section 1 on pages 1 - 16.)

### Custom blended steel versus common grades of steel

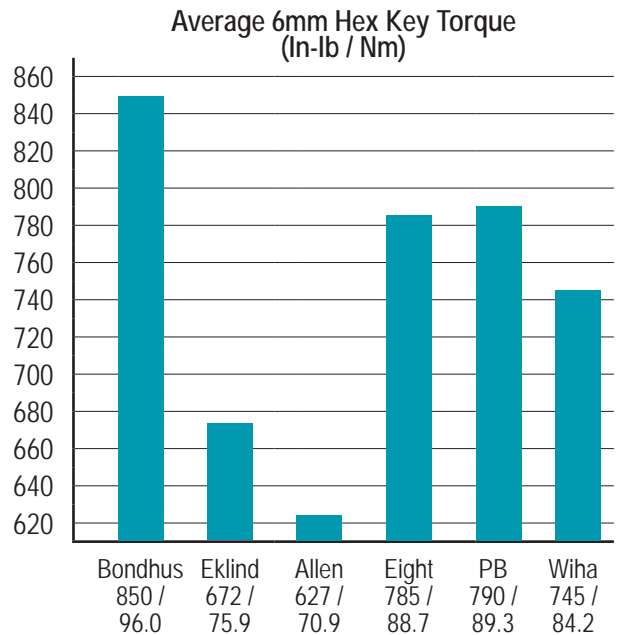
In the broadest possible terms, only two categories of steel are used in the manufacturing of hex and Star tools; custom blended steel and standard grades of steel. A simple comparison makes it easy to see why Bondhus custom blended Protanium® Steel achieves far greater levels of performance than standard grades of steel:

Custom blended Protanium® Steel	Standard grades of steel
A custom blend specifically designed for the rigors and requirements of hex and Star tools	Standard grades of steel are a one-size-fits-all solution, designed for a range of uses, not just hex and Star tools
The elements making up the steel's composition and the process used to produce the steel are customized to the Protanium® Steel specification, enabling use of customized heat treating processes that produce tools with greater hardness and ductility	The tool manufacturer has no control over the steel's blend. Heat treating cannot be customized beyond the limitations of the standard blend
Imperfections are eliminated through the addition of specific elements and by controlling the methods by which mills produce the steel	Tool manufacturer has no control over the steel's production or imperfections that may result
Meticulous quality control, monitoring and documentation are enforced by the Protanium® Steel specification	Steel mills perform their own “standard” quality control
The drawing process is controlled to produce stock with highly precise dimensional accuracy, sharp corners and smooth clean surfaces	Tool manufacturer has little control over drawing process

# T-Handle Tools

Except for Bondhus, all other hex and Star tool manufacturers use various standard grades of steel in the manufacturing of their tools:

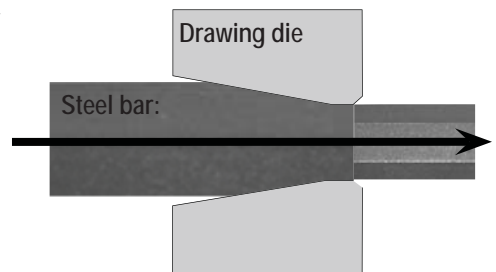
- 8650 is the most common grade in use throughout the U.S. and Asia. It does not achieve the hardness or ductility levels of Protanium® steel.
- Chrome Vanadium is comparable in performance to 8650. It is used primarily in Europe.
- Chrome Moly is similar to Chrome Vanadium, but is somewhat stronger and harder. Because it is fairly expensive, manufacturers generally only use it on their higher priced tools like ball end products, and substitute lower grades for their hex and folding tools. Europe and Japan are the primary users.
- S2 is used by only a small number of manufacturers. It is harder than 8650, but it is also less ductile, more costly, and far more prone to shattering.
- Carbon steel grades, such as 1050, are low-grade steels that are inferior to those listed above. They are still used by some manufacturers in Europe and Asia.



## ► *Bondhus controlled steel drawing process*

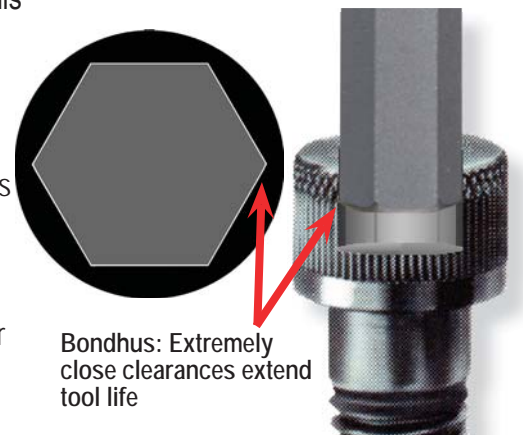
Changing the size or shape of a metal bar or rod by pulling it through a die is known as drawing. It is a critical process in the production of high quality steel, since it determines the dimensional precision and surface quality of the steel.

Standard grades of steel are drawn to tolerances that do not conform to the Protanium® Steel specification for precision, so Bondhus exercises full control over the drawing process. Bondhus works closely with its' steel suppliers to ensure 100% compliance with the Protanium® Steel drawing specification, and will not work with any mill unwilling to make this commitment.



## Close clearances

Tolerances imposed by the Protanium® Steel drawing specification produce stock so precisely drawn that clearances between a Bondhus tool tip and the screw walls is typically one half thousandth of an inch or less. Clearances this close produce tool tips with greater surface area contacting the screw walls. Smaller clearances between the tool surface and the screw head mean Bondhus tools greatly reduce wear of tool tips and screw heads, and reduce or eliminate the potential of stripping.



# T-Handle Tools

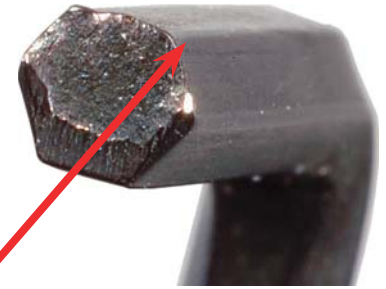
## Sharp corners

Another requirement of the Protanium® Steel drawing specification is that corners be sharp and smooth. Eliminating gaps between the tool tip corners and the screw walls means tool tip surface area increases. Tool tip and screw head wear is greatly reduced, since the primary cause of screw stripping has been eliminated.

Standard grades of steel allow far more rounding of corners during the drawing process and surfaces that are not nearly as smooth, so the process of tool wear and screw stripping is accelerated. Once again, tools made with standard grades of steel perform inconsistently and unreliably.



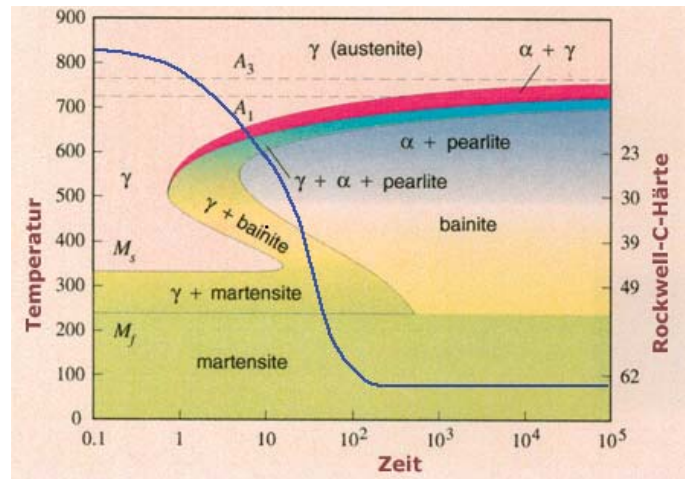
Bondhus: Sharp, clean corners



Competitors: Rounded corners accelerate wear and stripping

## ► Customized heat treating process assures optimal combination of hardness and ductility

Heat treating is a series of processes where steel is heated to a temperature referred to as its *transformation point*, where its atomic structure actually changes. It is then cooled (quenched) in a highly controlled process where it is held at a specific *temperature* for a precise period of *time*. Complex documents known as TTT Charts (Time / Temperature / Transform) show this relationship. They assist in determining an optimal heating and quenching cycle for obtaining desired properties such as optimal microstructure, grain size, hardness and ductility.



Sample TTT chart

## Truly customized heat treating

An essential point to understand about heat treating is that the blend of the steel largely determines how and to what extent desired properties of the steel can be obtained in the heat treating process. In other words, controlling and customizing the blend of the steel is the only means by which truly customized heat treating can be accomplished. Protanium® Steel starts as a custom blended steel, and is transformed into hard, ductile tools by customized heat treat processes.

- Competitors must perform their heat treating to accommodate the limitations of the standard grades of steel they purchase. Since they have no control over the blend of the steel, their heat treating cannot achieve the levels of hardness and ductility achieved by Protanium® Steel.
- Bondhus continually improves the blend of Protanium® Steel to achieve full customization of the heat treating process. With full control of the steel's blend and its heat treating, Protanium® Steel is capable of achieving levels of hardness and ductility well beyond the limitations of the standard grades of steel used by competitors

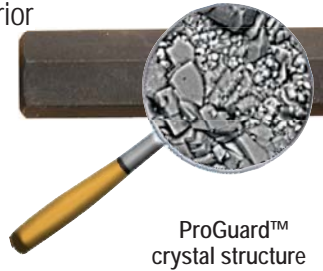


# T-Handle Tools

## 20) Worlds best corrosion protection - ProGuard™ Dry Surface Technology

### ► ProGuard™ surface is impermeable to moisture and contaminants

ProGuard™ dry surface protection represents a dramatic improvement over traditional methods of protecting hex and Star tools. The ProGuard™ crystal structure provides a superior barrier against elements that cause rust and corrosion. It protects the tool for a lifetime of use and keeps tools looking attractive.



ProGuard™  
crystal structure

Independent lab testing has proven ProGuard™ finish is up to five times more effective than alternative finishes offered by competitors.

### ► Finish is dry and clean with a final light coating of oil

**Bondhus:** The ProGuard™ finish locks out moisture and contaminants without the ongoing requirement of an oily surface. ProGuard™ tools receive a light coat of oil prior to packaging, but do not rely on oil as their primary means of protection. Tool user's hands and work areas remain dry and clean.

**Competitors:** Tools with inadequate protection rely on the user to keep the surface sealed with oil. Tools are dirty, messy and unpleasant to work with, and corrosion protection still remains inadequate.

### ► ProGuard™ finish is permanently bonded to surface of tool

**Bondhus:** ProGuard™ protection is a proprietary finish only available on Bondhus tools. It provides a permanent finish that cannot be wiped off like a black oxide or oil finish.

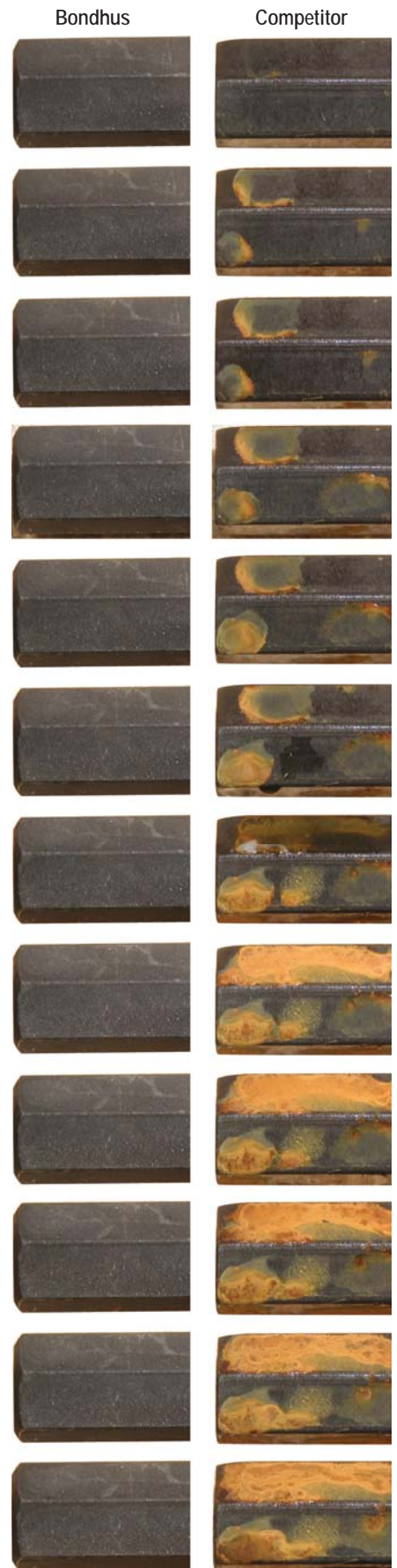
Application of the ProGuard™ finish starts with a thorough caustic cleaning of the tool's surface. A small grained crystal structure is then permanently bonded to the entire surface of the tool through a ten step process. The resulting tight structure makes it very difficult for moisture and contaminants to penetrate the surface.

Smooth surfaces and sharp corners provide further protection to Bondhus tools by denying moisture and contaminants places to collect.



Bondhus tool

## 12 hour time-lapse moisture test sequence



6

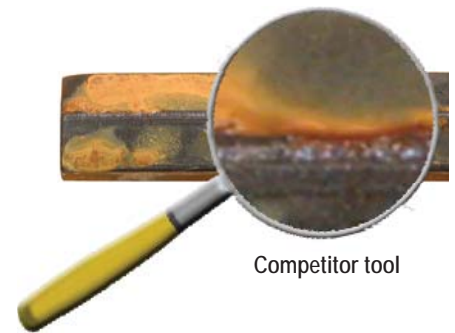
# T-Handle Tools

## ► Competitors:

Three basic finishes are typically used by competitors. Each has associated deficiencies, and none is ideally suited for the professional tool market:

- Black oxide is a coating that forms on the surface of a tool through a chemical reaction with iron. It's commonly used on tools and forgings to create a dark gray or black color, but is both porous and easily wiped off. In spite of the coating of oil normally used on it, corrosion starts forming almost immediately, sometimes before the tool has even been removed from its packaging.
- Plating provides a degree of protection, but it eventually nicks, flakes or wears off, and allows water to seep in.
- Some manufacturers simply dip tools in oil. Once wiped off, tools are left with no protection whatsoever.

Competitor's tools lack the consistent smooth surfaces and sharp corners of Bondhus tools, so moisture can easily accumulate and accelerate the spread of corrosion in competitor tools.



Competitor tool

## 21) Color coded handles (screwdrivers, folding tools and T-Handles) & cases (for hex, ball and Star sets)

Color coding of T-Handle and screwdriver handles and Bondhex™ cases makes inch, metric and Star tools easy to identify and distinguish from one another.

Inch	-	yellow
Metric	-	red
Star	-	green



## 22) Lifetime warranty

Bondhus manufactures the highest quality hex and Star tools available, and every tool is backed by an unconditional lifetime warranty.

***"All Bondhus products are guaranteed for life. If you are not satisfied with a Bondhus tool - for any reason - simply return it. A replacement will be shipped right out at no cost - no hassles, no questions asked."***

A warranty is only as good as the company standing behind it. Bondhus has been the leading innovator in the hex and Star tool industry for over forty years.



# T-Handle Tools

## Frequently Asked Questions

### *Why does Bondhus not manufacture ball end T-Handles in sizes smaller than 5/32" and 4mm?*

Bondhus does not manufacture ball end T-Handles in sizes smaller than 5/32" and 4mm because a T-Handle could easily over-torque and break smaller size ball end tips. Hex tips are provided on tools of these sizes, in order to prevent tip damage.

Bondhus is very conscientious about handle design on ball end tools. A ball end tip does not provide the user with the telltale "yield" a hex tip provides when it reaches its torque capacity, so it is more vulnerable to breakage due to accidental over torquing. Large competitor handles are capable of over torquing their tips and often times result in broken tools.

### *Why does Bondhus not offer extra long T-Handles?*

An extra long blade can occasionally be useful, but they are expensive and often difficult to use. Bondhus provides a more flexible solution. Bondhus Hextenders allow a blade to be coupled with the T-Handle blade for additional length when it is needed. The same Hextender can also be used to extend any hex or Star tool, and even greater lengths can be accomplished by using multiple Hextender/blade combinations.

### *Why are the handles on Bondhus T-Handles curved instead of straight?*

There are two reasons. First, the slight downward angle of the handle is more comfortable and ergonomically correct. Less strain will be felt in the wrists when the Bondhus handle is used, compared to older style, straight handles used by competitors. In addition, when using a one-handed grip, pressure is evenly distributed across the entire palm of the hand. Fatigue and pressure point related pain is minimized. Straight handles focus pressure on a few specific points of the hand, and are a primary cause of pain, fatigue and cramping.

### *Why does Bondhus stress welded handles as such an important feature?*

To extend tool life and protect the tool user, Bondhus handles are permanently welded to the blade. They will never loosen, fall out, slip or allow the blade to punch through the top of the handle. Competitor handles with blades merely pressed into the handle can put the tool user at risk of serious injury.



# ProHold® Screw Holding Technology

Bondhus ProHold® tools are designed and manufactured to be strong and save time. Every tool user recognizes the inconvenience, lost time and sometimes expensive problems resulting from dropped screws. In some industries, every fastener must be accounted for and every dropped screw retrieved. The ProHold® tip offers a complete solution to these problems. Bondhus invented the ProHold® tip to hold socket screws securely on the tip of the tool, even at an angle (with ball end tips). The tip is non-magnetic, will not rust and is safe to use around sensitive equipment. Bondhus' exclusive manufacturing processes ensure the highest level of machining consistency as each ProHold® tip is machined to incredibly tight tolerances. All Bondhus ProHold® tip tools are manufactured with Bondhus' exclusive Protanium® steel, which is up to 20% stronger than competitor tools and finished with its' proprietary ProGuard™ corrosion resistant finish. ProHold® tools are protected by US and foreign patents, ensuring ProHold® tip features and strength are only available from Bondhus.



## Features

- 1) Non-magnetic technology
- 2) Non-metallic button
- 3) Button located on flat of tool
- 4) ProHold® ball ends insert into screws at an angle
- 5) Tools available for very small sizes:  
As small as .050" & 1.27mm (ball)  
As small as T9 (Star)
- 6) Tools work at a 25 degree angle (ball end tools)
- 7) Superior ball end strength and working angle (ball end tools)
- 8) Funnel insertion (ball end tools)
- 9) Chamfered tool tips (short arm on ball end and Star L-keys)
- 10) Precise machining
- 11) Consistent 25 degree working angle on ball end tools

## Benefits

- 1) Works on all fastener types and safe to use on sensitive equipment. Also will not attract and hold metal filings or chips.
- 2) Will not rust and will hold non-magnetic screws (aluminum, stainless and plastic)
- 3) The tool lasts longer. The button will not wear during use.
- 4) Saves time because tool user can reach and turn screws that cannot be reached straight-in
- 5) Bondhus' extremely precise manufacturing methods create tools that work very well, even in very small sizes
- 6) Screws can be turned continuously, without constantly taking the tool out of the screw, repositioning it and reinserting it, even at angles up to 25 degrees.
- 7) Bondhus ball end tips are designed to be the perfect balance between angle and strength. Ball end strength is maximized, while still providing a consistent full 25 degrees of working angle.
- 8) Saves time because Bondhus ball ends automatically funnel themselves into the screw head and quickly seat to full depth
- 9) Saves time because burrs that might prevent insertion of the tool tip into the screw head are completely removed, so tip insertion is quick and easy
- 10) Saves time because precision machining means every Bondhus tool fits precisely into the screw head, minimizing breakage and stripping
- 11) Saves time because tool users can absolutely count on every Bondhus ball end tool to provide a full 25 degrees of working angle, period.





# ProHold® Screw Holding Technology

## Features

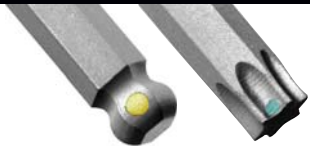
- 12) Handles matched to tip torque (Screwdrivers and T-Handles)
- 13) Worlds strongest tools - Protanium® Steel
- 14) Worlds best corrosion protection- ProGuard™ Dry Surface Technology
- 15) Color coded handles (Screwdrivers and T-Handles) & cases (for hex, ball and Star sets)
- 16) Bondhex™ case
- 17) Lifetime warranty

## Benefits

- 12) T-Handle and screwdriver handles are sized to comfortably deliver an appropriate level of torque and assist in preventing damage to ball end tips.
- 13) Saves time because Bondhus' exclusive Protanium® Steel makes Bondhus tools up to 20% stronger than competitor tools and allows the tool user to deliver more torque without breaking the tool or damaging the screw head.
- 14) Saves time because the tool user does not have to work with rusty tools. ProGuard™ protection delivers up to 5 times the corrosion resistance of any other hex or Star tool finish.
- 15) Saves time because the tool user can quickly identify inch (yellow), metric (red) and Star (green) tools
- 16) Saves time because tools are neatly organized and locked in place to prevent loss. Tools are easily removed from the case with a slight twist of the tool.
- 17) Bondhus stands behind every sale with a "No questions asked" life-time replacement policy.

\* Bondhus, Bondhex, ProGuard, Protanium, Balldriver, BallStar, GorillaGrip, BriteGuard and GoldGuard are trademarks of Bondhus Corporation.

# ProHold® Screw Holding Technology



Traditional ball end, hex, and Star tools were not designed to be screw holding tools, and in the past, screw holding tools had significant drawbacks and limitations. Tool users had to tolerate the expense and inconvenience of owning multiple types of screw holding tools, because each was only appropriate for certain types of tasks.

ProHold® tools perform the same functions as standard hex, ball end and Star tools, without the limitations of tips that lack screw holding capabilities. ProHold® tips make short work of difficult tasks, and save tool users valuable time.

Lifting a screw from a counter bored hole, or guiding an unthreaded screw out of a horizontal hole is extremely difficult with a standard tip tool. ProHold® tools were designed to accomplish these tasks quickly and easily, with no fear of dropping the screw.

A ProHold® tip holds screws so securely, that even when the tool is intentionally shaken, the screw remains firmly on the tip.

Ball end tips were designed for angle insertion and extraction, but working in blind or difficult to reach locations can result in a dropped screw. ProHold® tools eliminate the potentially time consuming task of retrieving dropped screws. ProHold® ball end tips achieve the same working angle as standard Bondhus ball end tips and provide a full 360° of smooth rotational action.

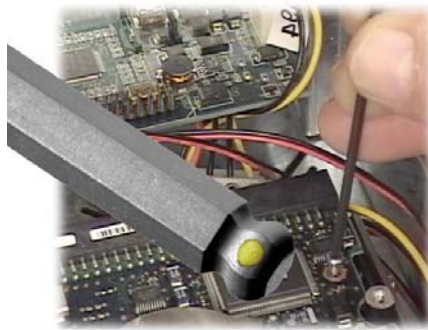
A screw can be pre-adjusted on a ProHold® tip to match the angle needed for insertion. Since the screw is held firmly on the tip, starting the thread in a difficult location becomes far easier to accomplish.

Today, with the introduction of Bondhus ProHold® tips, all screw holding solutions of the past are effectively obsolete. ProHold® technology is so versatile and works so well, there is no longer any reason to purchase a ball end tool without it.

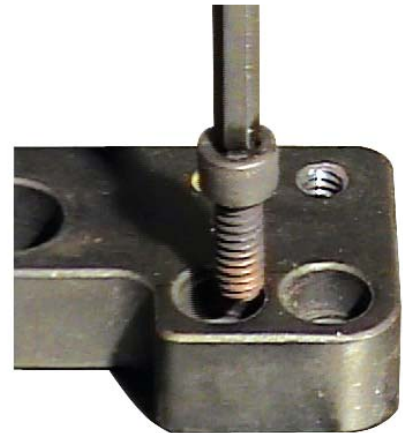
## 1) Non-magnetic tip

Since ProHold® tip technology is non-magnetic, it can be used in electronic applications with no fear of damaging sensitive components.

Magnetic tips attract steel shavings that must be thoroughly cleaned off the screw, prior to insertion. Failing to do so will interfere with screw threading and seating.



Safe for use in electronic applications



Lifts out screws with ease



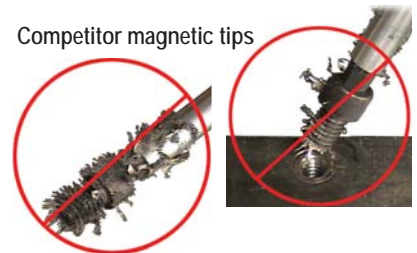
Angle insertion/extraction with no dropped screws



Will not attract metal shavings

# ProHold® Screw Holding Technology

A ProHold® tip will not attract metal shavings, so it can be used in any work environment. It does not rely on magnetism, so it works equally well with aluminum, stainless steel and plastic/nylon screws.



ProHold® tips will not collect shavings or deposit them in a screw hole

## 2) Non-metallic button

ProHold® tip technology has no metal parts or spring devices to break, rust or corrode. The ProHold® button is a highly durable synthetic material that will not cause premature wear or damage to aluminum, stainless steel or plastic/nylon screws. The button is designed to last the lifetime of the tool.



Non-metallic ProHold® button on flat of tip

## 3) Button located on flat of tool

**Bondhus:** The ProHold® tip design places the button on a flat of the tool tip, where strength is greatest. The design enables corners to retain 100% strength and achieve the high resistance to stripping that Bondhus tools are known for. A ProHold® tip seats to full depth in a screw head to maximize the tool surface area contacting the screw walls.



Competitor: Compromised corner strength

**Competitor:** The tool corners transmit all of the torque to the screw. Some competitor screw holding solutions compromise corner strength. The competitor tool tips often strip at torque levels well below recommended seating torque. Also, corrosion and contamination can render holding rings inoperative.

## 4) ProHold® ball ends insert into screws at an angle

Bondhus ball end tools are tremendous times savers. A hex tool can only be inserted in a screw head from a straight-on direction (0 degrees), but a Bondhus ProHold® ball end can enter from any angle up to 25 degrees, and insertion is quick and easy. The need to disassemble equipment to provide tool access to a screw head can be reduced or eliminated.



## 5) Tools available for very small sizes:

*As small as .050" & 1.27mm (ball end hex)*

*As small as T9 (Star)*

Bondhus manufactures a broad selection of ball end hex and Star tools for precision applications. Even in these incredibly small sizes, Bondhus tools maintain tight tolerances, highly precise machining and absolute consistency.

Bondhus precision machined tools will not strip fasteners, wear prematurely or damage delicate equipment to which repairs would be expensive and time consuming. Tool users can feel confident that Bondhus tools have the strength and precision to protect even their most delicate and expensive components.

.050"  
1.27mm  
(Ball end)      T9  
(Star)



# ProHold® Screw Holding Technology

## 6) Tools work at up to a 25 degree angle (ball end tools)

Working with a hex tool, near obstructions that block 360 degrees of handle rotation, can consume significant amounts of time. A standard hex tool must be removed and reinserted with every rotation of the screw, and often, screws can only be turned a fraction of a rotation at a time.



Hex tool constantly removed and re-inserted

**Bondhus:** When using a Bondhus ball end tool, the time and effort of working in those difficult blind or hard to reach locations is greatly reduced. A Bondhus ball end can provide continuous rotation, eliminating the time-consuming need to constantly remove and reinsert the tool.



Ball end tool provides continuous rotation

Angle insertion of a screw requires a sensitive feel to know when the thread has been started straight. This is especially important when working with small screw sizes, or inserting screws into soft materials like aluminum or plastic, which are prone to cross-threading. Bondhus ball ends minimize the possibility of cross-threading by providing a full 360 degrees of smooth rotation and preserving rotational sensitivity.



**Competitors:** An imprecisely machined ball end can deliver reduced working angle and can sacrifice smooth rotation, and in turn, not provide the sensitive feel necessary for starting a thread straight. Cross-threading can easily occur, and re-tapping a thread in a difficult location often requires time-consuming disassembly of equipment.



Competitor tool: Imprecise machining sacrifices smooth rotation

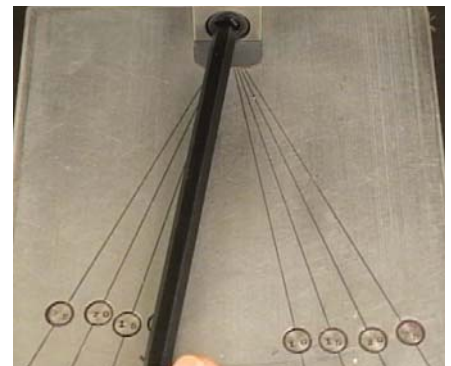
Some ball ends are not only poorly machined, they are also undersized. They can rotate smoothly only because of excessive clearance between the tip and socket walls, and give a misleading feel of precision. In just a short time, they will wear excessively, and stripping of the ball end or screw head will be the outcome.



Competitor tool: Imprecise machining causes undersized tips

## 7) Superior ball end strength and working angle

"Working angle" is the maximum angle at which a ball end can operate smoothly, while fully seated in the screw head. A quality ball end tool must provide good working angle without compromising neck strength. Bondhus ball end tools are designed to deliver a full 25 degrees of working angle, while delivering maximum neck strength.

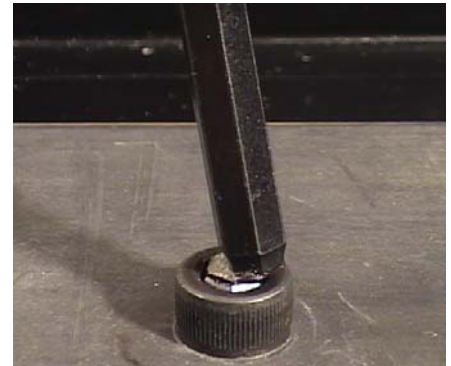


Competitor tool: Thick neck limits working angle to only 9°

# ProHold® Screw Holding Technology

**Competitors:** Competitors manufacture ball ends from common grades of steel that lack the strength of Bondhus Protanium® Steel. To compensate for inadequate strength, some manufacturers *increase* neck size. As neck size increases, however, working angle *decreases*. Strength is improved, but working angle becomes inadequate.

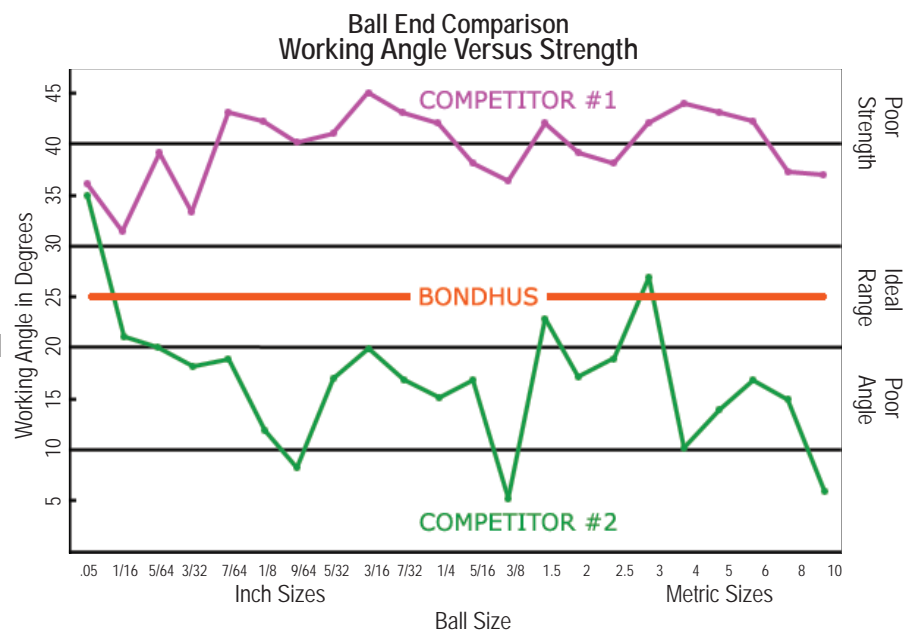
To achieve working angles up to 35°, some manufacturers *reduce* neck size. Reduced neck size decreases strength, and as the recommended seating torque for the screw is approached, the risk of breakage increases. A broken tip can mean a substantial loss of time if the broken ball end jams itself in the screw head or damages the screw head.



Competitor tool: Thin neck size risks breakage

**Bondhus:** Bondhus ball end tools achieve the ideal balance between working angle and strength. The strength of Protanium® Steel allows a neck size that delivers a full 25 degrees of working angle, while maintaining superior strength and wear resistance.

A blade with a hex tip begins to yield when maximum torque is reached. The tool user can easily feel that yield, and by not applying additional torque, breakage can be avoided. In contrast, a ball end tip provides no warning of impending breakage to the tool user. When over-torqued, it breaks without warning. This is one of the reasons why the strength of a Protanium® Steel ball end is such an important feature.



## 8) Funnel insertion

Bondhus ball ends insert smoothly and are faster and easier to insert into a screw head than a hex tip. The concept by which the ball end channels itself into a screw head is known as funnel insertion. Precise design and machining ensure that the sides of the ball funnel the tip into the screw head and seat to full depth.



# ProHold® Screw Holding Technology

## 9) Chamfered tool tips (short arm on ball end and Star L-keys)

**Bondhus:** Bondhus uses a precise method of cutting, and then chamfers tips to eliminate any possibility of burrs. The chamfering makes insertion of a straight hex or Star tip into a screw head much easier. Bondhus employs several styles of chamfers, using each style where it is most effective. The type of chamfer used is not critical. The point is to ensure burrs are removed from all hex and Star keys. Bondhus hex and Star tips always insert smoothly and seat to full depth for optimal torque and longer tool life.

**Competitors:** Imprecise methods of cutting produce burrs on the tips of hex and Star keys. It is common for burrs to be so large, they need to be filed away before the tool will insert into a screw head.

The clearance between a hex key and the screw walls is typically .0005" (.0127mm) or less on each side of the key, and even a very small burr can interfere with or prevent insertion. If the socket of a screw head is on the small side of its tolerance, and the hex key is on the large side of its tolerance, any amount of burr will prevent proper insertion of the tip into the screw head.

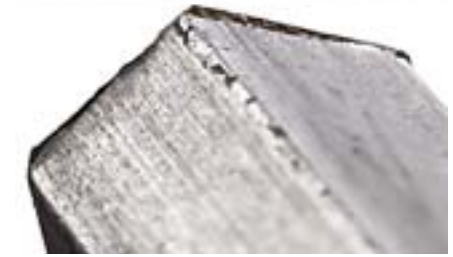
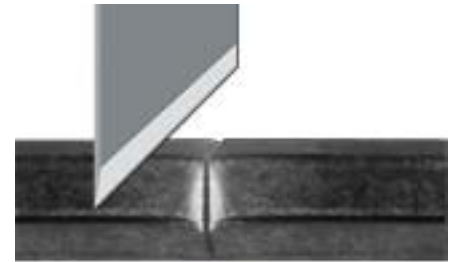
Competitor tools often feel snug in a screw head when first used, and then feel loose after only a couple of uses. The reason this happens is their tips often contain burrs. The burrs make the tool initially feel snug, but as soon as they wear off, the tips loose fit becomes obvious, and it proceeds to wear both the tool tip and the screw head quickly.

An imprecise cutting process can also distort the tool tip, causing it to be undersized, and to be slightly bent. Even chamfering or filing will not correct a problem of this severity.

As a last consideration, the cutting process can produce what is known as lips on the tip of a tool. Protrusions of this nature will prevent the tip from seating to the full depth in the screw head, thus increasing wear and the potential for stripping both the tool and the screw head.



Chamfered Bondhus tip



Competitor: Imprecise cutting causes burrs on tips



Competitor: Tip bent by cutting process



Competitor: Tip with lips will not seat to full depth



# ProHold® Screw Holding Technology

## 10) Precise machining

**Bondhus:** Professional tool users recognize the Bondhus name as synonymous with quality, consistency and reliability. Bondhus is meticulous about quality and the enforcement of the tightest specifications in the hex and Star tool industry. Every tool Bondhus manufactures is subject to its own set of specifications and a company policy of no exceptions or deviations. Specifications are enforced by quality assurance testing at every stage of the manufacturing process.

Precision machining is critical for a ball end tool to function optimally. Understandably, the smaller a ball end tip is, the more complex the task of machining becomes.

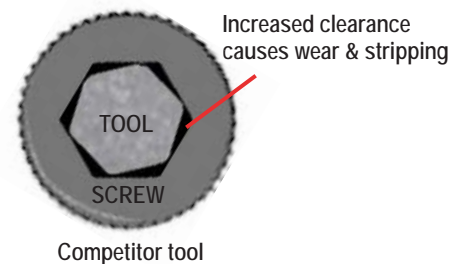
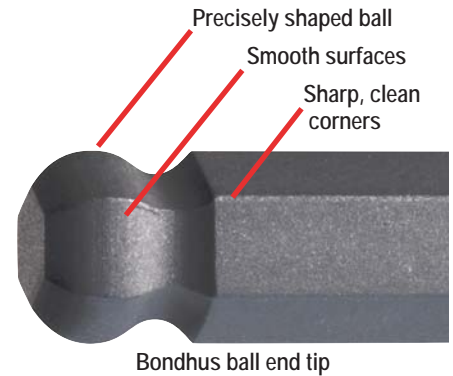
Bondhus maintains incredibly tight tolerances and close clearances between ball end tips and the screw head walls. Bondhus machining accurately maintains the precise geometric shape of the ball on all six sides. Surfaces are smooth, and corners are sharp and clean, even on a tool as small as .050" (1.27mm).

Precise machining results in Bondhus ball end tips having more surface area contacting the screw walls than any other competitor. Bondhus ball end tools far outwear the competition, and dramatically reduce stripping. Fastener wear is also greatly reduced.

**Competitors:** Claims of quality and precision are also made by competitors who often represent their tools as "comparable", "nearly comparable" or "good enough" when compared to Bondhus tools. Bondhus encourages head-to-head comparison and is pleased to provide all the information necessary for professional tool users to make their own informed decisions.

The ball end to the right is so poorly machined, it cannot even hold a screw in a horizontal position. Working in a blind or difficult location would be nearly impossible with this poorly machined tool tip.

Poorly machined ball ends do not just compromise working angle. Imprecise machining can cause tips to be under-sized and not symmetrical. The clearance between the tip and screw walls increases, causing excessive wear and stripping.

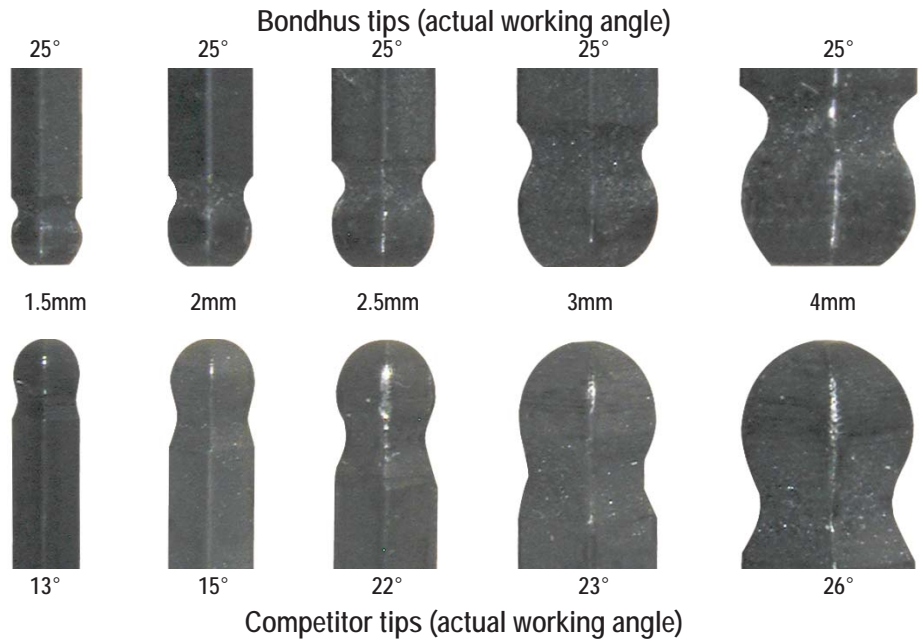


# ProHold® Screw Holding Technology

## 11) Consistent 25 degree working angle on ball end tools

**Bondhus:** Bondhus ball end tips are precisely machined to provide a consistent 25 degrees of working angle, regardless of how large or small the tool is.

**Competitors:** Comparing Bondhus ball ends to those of a well known competitor, the differences are quite dramatic. Wide tolerances and imprecise machining cause many competitor ball ends to have an irregular ball shape. Wide variations in working angle from one tool to the next is the result, with some tools having less than 15° of working angle.



The competitor who manufactures these tools claims a 30° working angle. Actual measurement though, showed large inconsistencies from one tool to the next, and none were capable of reaching 30°.

## 12) Handles matched to tip torque (screwdrivers and T-Handles)

**Bondhus:** A screwdriver is capable of over-torqueing its blade and can easily result in damage to the tool. Bondhus is the only manufacturer to design handles matched to the torque capacity of their blades and tips. Whether using a hex, Star or ball end tip, tool users can feel confident that applying torque will not result in breakage or damage to a Bondhus screwdriver.



A T-Handle that is too large can easily generate too much torque and risk blade or tip damage. A T-Handle that is too small requires wasted effort to generate required torque, resulting in needless user fatigue. The handles on all Bondhus T-Handles are sized to strike a balance between ease of use and protection against tool damage. Handles are large enough to easily and comfortably generate needed torque, yet small enough to help prevent accidental over-torqueing that could damage the blade or tip.

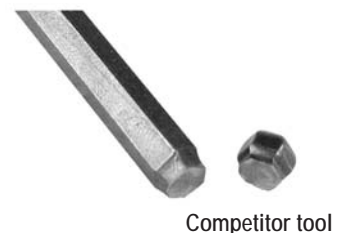
Bondhus does not manufacture ball end T-Handles in sizes smaller than 5/32" and 4mm. A T-Handle could easily over-torque and break smaller size ball end tips. Hex tips are provided on tools of these sizes, in order to prevent tip damage.

Inch	Metric
3/32"	2mm
7/64"	2.5mm
1/8"	3mm
9/64"	

T-Handles with hex tips

**Competitors:** Many screwdriver and T-Handle tools are available with handles that far exceed the torque capacity of their blades or tips. Damage and breakage, caused by over-torqueing, is common to these tools.

A handle this large, is capable of generating more torque than this ball end tip can deliver. Without warning, the tip can easily be broken off.





# ProHold® Screw Holding Technology

## 13) Worlds strongest tools -Protanium® Steel

### ► Protanium® High Torque Steel - a custom blended steel

Protanium® Steel is much more than “just steel” and much more than a “name”. It is a commitment to producing a level of tool performance unmatched by any competitor. Protanium® High Torque Steel is not an 8650 grade of steel, it is not a form of S-2 and it is not a chrome-vanadium or chrome-moly type of steel. Protanium® High Torque Steel is custom mixed to a formula that is the result of many years of research and continuous development efforts. Bondhus’ customized heat treating processes are the key to bringing out the superior strength properties of Protanium® High Torque Steel. Attaining results that push beyond the accepted limits of performance requires the skill and years of research and development that Bondhus alone has committed itself to.

(For more in-depth information on Protanium® Steel, please refer to Section 1 on pages 1 - 16.)

### Custom blended steel versus common grades of steel

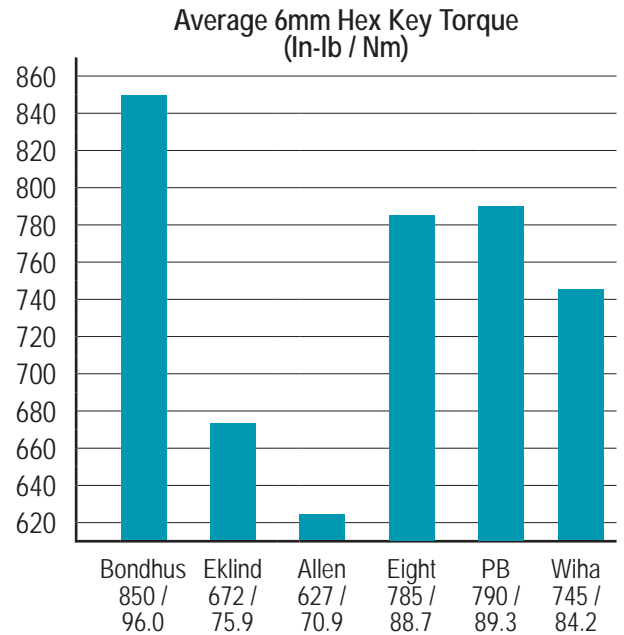
In the broadest possible terms, only two categories of steel are used in the manufacturing of hex and Star tools; custom blended steel and standard grades of steel. A simple comparison makes it easy to see why Bondhus custom blended Protanium® Steel achieves far greater levels of performance than standard grades of steel:

Custom blended Protanium® Steel	Standard grades of steel
A custom blend specifically designed for the rigors and requirements of hex and Star tools	Standard grades of steel are a one-size-fits-all solution, designed for a range of uses, not just hex and Star tools
The elements making up the steel's composition and the process used to produce the steel are customized to the Protanium® Steel specification, enabling use of customized heat treating processes that produce tools with greater hardness and ductility	The tool manufacturer has no control over the steel's blend. Heat treating cannot be customized beyond the limitations of the standard blend
Imperfections are eliminated through the addition of specific elements and by controlling the methods by which mills produce the steel	Tool manufacturer has no control over the steel's production or imperfections that may result
Meticulous quality control, monitoring and documentation are enforced by the Protanium® Steel specification	Steel mills perform their own “standard” quality control
The drawing process is controlled to produce stock with highly precise dimensional accuracy, sharp corners and smooth clean surfaces	Tool manufacturer has little control over drawing process

# ProHold® Screw Holding Technology

Except for Bondhus, all other hex and Star tool manufacturers use various standard grades of steel in the manufacturing of their tools:

- 8650 is the most common grade in use throughout the U.S. and Asia. It does not achieve the hardness or ductility levels of Protanium® steel.
- Chrome Vanadium is comparable in performance to 8650. It is used primarily in Europe.
- Chrome Moly is similar to Chrome Vanadium, but is somewhat stronger and harder. Because it is fairly expensive, manufacturers generally only use it on their higher priced tools like ball end products, and substitute lower grades for their hex and folding tools. Europe and Japan are the primary users.
- S2 is used by only a small number of manufacturers. It is harder than 8650, but it is also less ductile, more costly, and far more prone to shattering.
- Carbon steel grades, such as 1050, are low-grade steels that are inferior to those listed above. They are still used by some manufacturers in Europe and Asia.



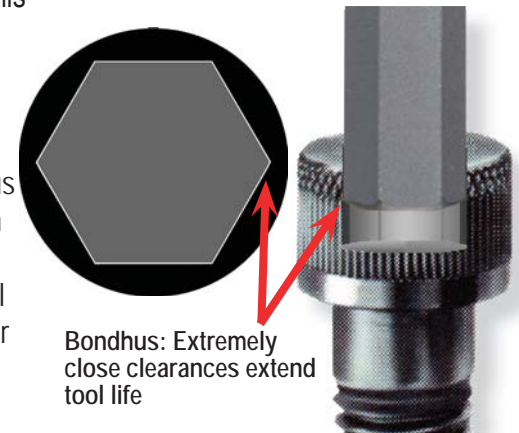
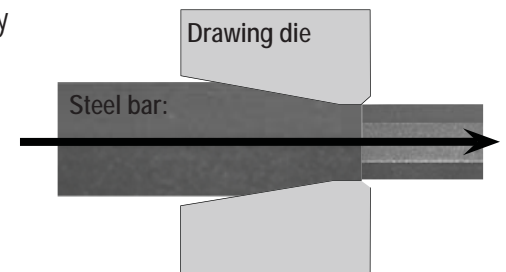
## ► Bondhus controlled steel drawing process

Changing the size or shape of a metal bar or rod by pulling it through a die is known as drawing. It is a critical process in the production of high quality steel, since it determines the dimensional precision and surface quality of the steel.

Standard grades of steel are drawn to tolerances that do not conform to the Protanium® Steel specification for precision, so Bondhus exercises full control over the drawing process. Bondhus works closely with its' steel suppliers to ensure 100% compliance with the Protanium® Steel drawing specification, and will not work with any mill unwilling to make this commitment.

### Close clearances

Tolerances imposed by the Protanium® Steel drawing specification produce stock so precisely drawn that clearances between a Bondhus tool tip and the screw walls is typically one half thousandth of an inch or less. Clearances this close produce tool tips with greater surface area contacting the screw walls. Smaller clearances between the tool surface and the screw head mean Bondhus tools greatly reduce wear of tool tips and screw heads, and reduce or eliminate the potential of stripping.



# ProHold® Screw Holding Technology

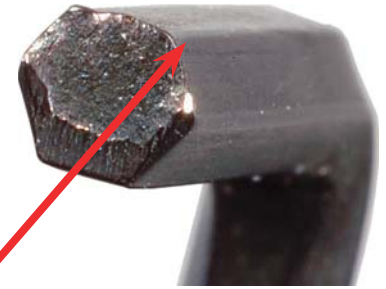
## Sharp corners

Another requirement of the Protanium® Steel drawing specification is that corners be sharp and smooth. Eliminating gaps between the tool tip corners and the screw walls means tool tip surface area increases. Tool tip and screw head wear is greatly reduced, since the primary cause of screw stripping has been eliminated.



Bondhus: Sharp, clean corners

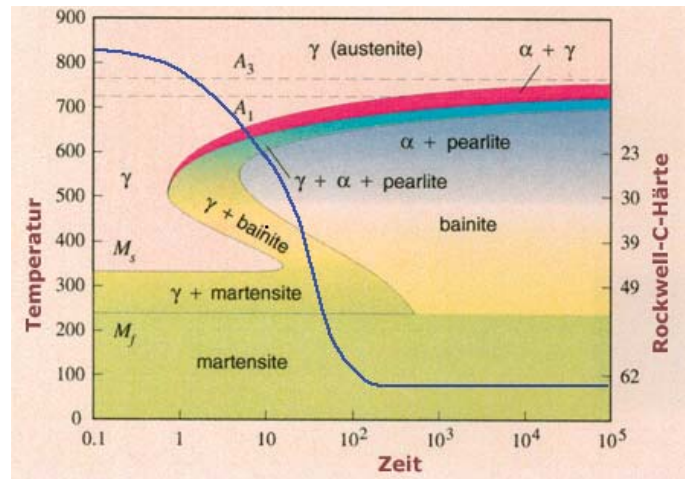
Standard grades of steel allow far more rounding of corners during the drawing process and surfaces that are not nearly as smooth, so the process of tool wear and screw stripping is accelerated. Once again, tools made with standard grades of steel perform inconsistently and unreliably.



Competitors: Rounded corners accelerate wear and stripping

## ► Customized heat treating process assures optimal combination of hardness and ductility

Heat treating is a series of processes where steel is heated to a temperature referred to as its *transformation point*, where its atomic structure actually changes. It is then cooled (quenched) in a highly controlled process where it is held at a specific *temperature* for a precise period of *time*. Complex documents known as TTT Charts (Time / Temperature / Transform) show this relationship. They assist in determining an optimal heating and quenching cycle for obtaining desired properties such as optimal microstructure, grain size, hardness and ductility.



Sample TTT chart

## Truly customized heat treating

An essential point to understand about heat treating is that the blend of the steel largely determines how and to what extent desired properties of the steel can be obtained in the heat treating process. In other words, controlling and customizing the blend of the steel is the only means by which truly customized heat treating can be accomplished. Protanium® Steel starts as a custom blended steel, and is transformed into hard, ductile tools by customized heat treat processes.

- Competitors must perform their heat treating to accommodate the limitations of the standard grades of steel they purchase. Since they have no control over the blend of the steel, their heat treating cannot achieve the levels of hardness and ductility achieved by Protanium® Steel.
- Bondhus continually improves the blend of Protanium® Steel to achieve full customization of the heat treating process. With full control of the steel's blend and its heat treating, Protanium® Steel is capable of achieving levels of hardness and ductility well beyond the limitations of the standard grades of steel used by competitors

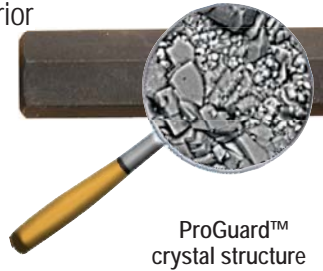


# ProHold® Screw Holding Technology

## 14) Worlds best corrosion protection - ProGuard™ Dry Surface Technology

### ► ProGuard™ surface is impermeable to moisture and contaminants

ProGuard™ dry surface protection represents a dramatic improvement over traditional methods of protecting hex and Star tools. The ProGuard™ crystal structure provides a superior barrier against elements that cause rust and corrosion. It protects the tool for a lifetime of use and keeps tools looking attractive.



ProGuard™  
crystal structure

Independent lab testing has proven ProGuard™ finish is up to five times more effective than alternative finishes offered by competitors.

### ► Finish is dry and clean with a final light coating of oil

**Bondhus:** The ProGuard™ finish locks out moisture and contaminants without the ongoing requirement of an oily surface. ProGuard™ tools receive a light coat of oil prior to packaging, but do not rely on oil as their primary means of protection. Tool user's hands and work areas remain dry and clean.

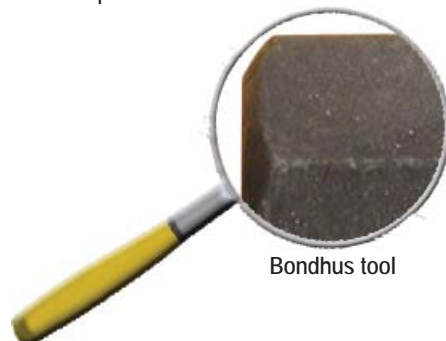
**Competitors:** Tools with inadequate protection rely on the user to keep the surface sealed with oil. Tools are dirty, messy and unpleasant to work with, and corrosion protection still remains inadequate.

### ► ProGuard™ finish is permanently bonded to surface of tool

**Bondhus:** ProGuard™ protection is a proprietary finish only available on Bondhus tools. It provides a permanent finish that cannot be wiped off like a black oxide or oil finish.

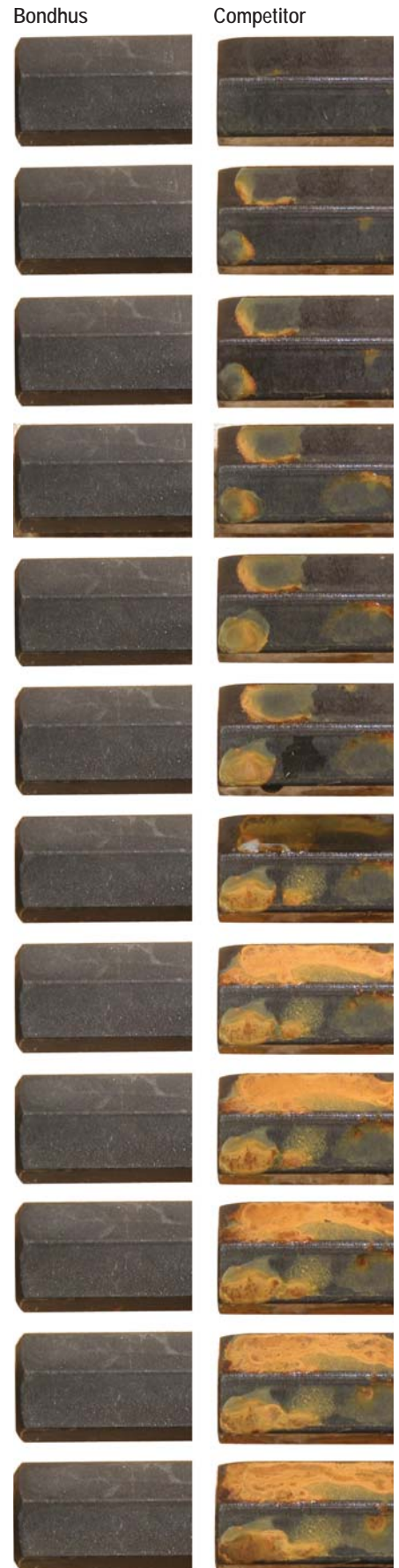
Application of the ProGuard™ finish starts with a thorough caustic cleaning of the tool's surface. A small grained crystal structure is then permanently bonded to the entire surface of the tool through a ten step process. The resulting tight structure makes it very difficult for moisture and contaminants to penetrate the surface.

Smooth surfaces and sharp corners provide further protection to Bondhus tools by denying moisture and contaminants places to collect.



Bondhus tool

## 12 hour time-lapse moisture test sequence



# ProHold® Screw Holding Technology

## 15) Color coded handles (screwdrivers, folding tools and T-Handles) & cases (for hex, ball and Star sets)

Color coding of T-Handle and screwdriver handles and Bondhex™ cases makes inch, metric and Star tools easy to identify and distinguish from one another.

Inch	-	yellow
Metric	-	red
Star	-	green



16) **Bondhex™ case (for ball end, hex and Star key sets)** Bondhus ball end, hex and Star key sets include the color coded Bondhex™ case to keep tools neat and sorted. A simple 60 degree turn locks keys in place to eliminate loose, spilled and lost keys, and tool sizes are clearly printed beneath each tool for quick size selection. A Bondhex™ case can also be used with a hex key to increase grip and comfortably generate additional torque.



17) **Lifetime warranty** Bondhus manufactures the highest quality hex and Star tools available, and every tool is backed by an unconditional lifetime warranty.

*"All Bondhus products are guaranteed for life. If you are not satisfied with a Bondhus tool - for any reason - simply return it. A replacement will be shipped right out at no cost - no hassles, no questions asked."*

A warranty is only as good as the company standing behind it. Bondhus has been the leading innovator in the hex and Star tool industry for over forty years.



# ProHold® Screw Holding Technology

## Frequently Asked Questions

### *Is the ProHold® button durable?*

YES. It is made of an extremely durable synthetic material and will not corrode, become brittle, chip or break. It is designed to last the lifetime of the tool.

### *Why is ProHold® technology superior to other screw-holding technologies?*

Non-magnetic ProHold® technology can be used in electronics applications, with plastic or aluminum fasteners, and will not attract metal shavings like magnetized tools do. It has no springs or other mechanical devices that can corrode, plug, weaken or break. The ProHold® button does not weaken the tool tip.

### *Does ProHold® technology work with all fastener types? (plastic, aluminum, stainless, etc.)*

YES. This is a primary feature of ProHold® technology. It is not magnetic, so it can be used in electronics applications and with all types of plastic, aluminum, etc fasteners.

### *Does the ProHold® button compromise the fit of the tool in the fastener?*

NO. ProHold® tools maintain the close clearances between the tool tip and the screw walls that all Bondhus tools are known for. In addition, it does not promote premature tip wear as some competitor solutions do.

### *How does ProHold® technology differ from the MagicRing®?*

A ProHold® button will not corrode, plug, weaken or break like a spring device can. Even more important, the ProHold® button is located on the flat of the tool and does not compromise the strength of the tip.

The MagicRing® tip relies on a groove machined around the tool tip. This groove can corrode or become damaged during normal use, causing the ring to stop functioning. Because the machined groove removes material from the corners of the tool tip, the tip can strip when a low level of torque is applied, especially in smaller sizes of tools.



# Screwdriver Tools

Bondhus screwdriver and wing/flag tools are designed and manufactured to be strong and save time. Bondhus is the only hand tool manufacturer to design handle sizes proportional to the strength of the tool tip. This attention to detail reduces the possibility of applying too much torque to the tool tip, which could result in stripping or breaking of the tool tip or the screw head. All handles have cushioned surfaces to reduce fatigue during use and to improve grip, even when hands are wet or oily. All handles are designed to stay where they are put and will not roll off an inclined or vibrating surface. All Bondhus handles are color coded for easy identification; Inch=yellow, Red=metric, Green=star and star plus.



## Features

- 1) Ergonomic handle design
- 2) Non-slip grip
- 3) Two component handle with tough inner core and cushioned rubber exterior
- 4) Anti-roll design
- 5) Ball ends insert into screws at an angle
- 6) Tools available for very small sizes:  
As small as .050" & 1.27mm (ball)  
As small as T5 (Star)
- 7) Tools work at a 25 degree angle (ball end tools)
- 8) Superior ball end strength and working angle (ball end tools)
- 9) Funnel insertion (ball end tools)
- 10) Chamfered tool tips (Star tools)
- 11) Precise machining
- 12) Consistent 25 degree working angle on ball end tools
- 13) Handles matched to tip torque
- 14) Worlds strongest tools -Protanium® Steel

## Benefits

- 1) Greatly reduces pain and fatigue associated with repetitive tasks or application of torque
- 2) Generates maximum torque, even with wet or oily hands
- 3) Increased comfort and durability because thermoplastic core resists breakage and splitting, while outer surface is cushioned
- 4) Tool resists rolling off inclined or vibrating surfaces
- 5) Saves time because tool user can reach and turn screws that cannot be reached straight-in
- 6) Bondhus' extremely precise manufacturing methods create tools that work well, even in very small sizes
- 7) Screws can be turned continuously, without constantly taking the tool out of the screw, repositioning it and reinserting it, even at angles up to 25 degrees.
- 8) Bondhus ball end tips are designed to be the perfect balance between angle and strength. Ball end strength is maximized, while still providing a consistent full 25 degrees of working angle.
- 9) Saves time because Bondhus ball ends automatically funnel themselves into the screw head and seat to full depth
- 10) Saves time because burrs that might prevent insertion of the tool tip into the screw head are completely removed, so tip insertion is quick and easy
- 11) Saves time because precision machining means every Bondhus tool fits precisely into the screw head, minimizing breakage and stripping
- 12) Saves time because tool users can absolutely count on every Bondhus ball end tool to provide a full 25 degrees of working angle, period.
- 13) Screwdriver and T-Handle handles are sized to deliver a safe level of torque that will not damage their ball end tips.
- 14) Saves time because Bondhus' exclusive Protanium® Steel makes Bondhus tools up to 20% stronger than competitor tools and allows the tool user to deliver more torque without breaking the tool or damaging the screw head.

# Screwdriver Tools

## Features

- 15) Worlds best corrosion protection - ProGuard™ Dry Surface Technology
- 16) Color coded handles (screwdrivers, folding tools, and T-handles)
- 17) Lifetime warranty
- 18) ProGuard™ (black), BriteGuard™ (chrome) and GoldGuard™ (14k gold) finishes

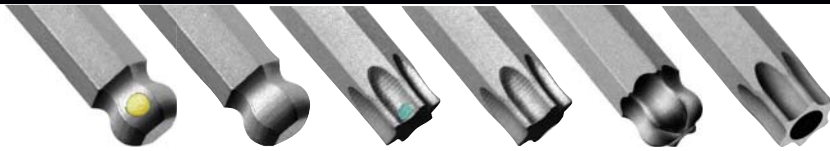
## Benefits

- 15) Saves time because the tool user does not have to work with rusty tools. ProGuard™ protection delivers up to 5 times the corrosion resistance of any other hex or Star tool finish.
- 16) Saves time because the tool user can quickly identify inch (yellow), metric (red) and star (green) tools
- 17) Bondhus stands behind every sale with a “No questions asked” lifetime replacement policy
- 18) Tool users have a wide range of finish choices to fit virtually every need.

\* Bondhus, Bondhex, ProGuard, Protanium, Balldriver, BallStar, GorillaGrip, BriteGuard and GoldGuard are trademarks of Bondhus Corporation.

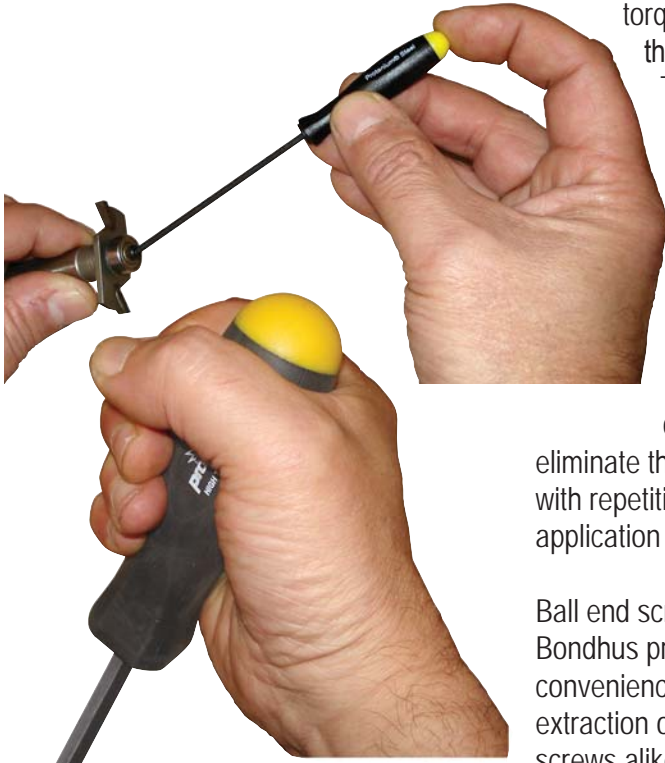


# Screwdriver Tools



## 1) Ergonomic handle design

**Bondhus:** Screwdriver handles from Bondhus feature a unique level of comfort by distributing torque evenly across the palm and fingers. The cushioned positive grip assists in generating maximum torque, while pain and fatigue are greatly reduced. Smooth curved surfaces eliminate edges that dig into the hand, and eliminate the blisters associated with repetitive tasks and the application of torque.



Ball end screwdrivers from Bondhus provide comfort and convenience for insertion or extraction of large and small screws alike. They can save time in assembly applications and tasks performed on a repetitive basis.

**Competitors:** Old style acetate handles lack the ergonomic design benefits of Bondhus handles. They do not distribute pressure evenly across the hand, so discomfort and fatigue is increased. The lack of cushioning and rounded edges also increase blisters and cramping in the hand.



8

## 2) Non-slip grip

Working with wet or slippery hands is not a problem when using Bondhus screwdrivers. The slightly textured, high friction surface provides superior grip in nearly any work environment.

## 3) Two-component handle with tough inner core and cushioned rubber exterior

Bondhus screwdrivers are manufactured with a tough thermoplastic inner core that resists cracking and splitting. A cushioned rubber exterior is injection molded over the inner core, and provides a highly durable surface that enhances comfort and grip.

## 4) Anti-roll design

ComfortGrip handles are designed to prevent rolling on vibrating surfaces, or inclined surfaces of up to 15 degrees.



Bondhus two-component handle

Thermoplastic inner core

Injection molded outer cover



# Screwdriver Tools

**5) Ball ends insert into screws at an angle** Bondhus ball end tools are tremendous time savers. A hex or Star tip tool can only be inserted in a screw head from a straight-on direction (0 degrees), but a Bondhus ball end tip can enter from any angle up to 25 degrees, and insertion is quick and easy. The need to disassemble equipment to provide tool access to a screw head can be reduced or eliminated.



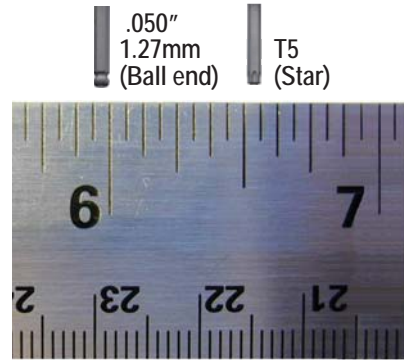
**6) Tools available for very small sizes:**

*As small as .050" & 1.27mm*

*As small as T5 (Star)*

Bondhus manufactures a broad selection of ball end hex and ball end Star tools for precision applications. Even in these incredibly small sizes, Bondhus tools maintain tight tolerances, highly precise machining and absolute consistency.

Bondhus precision machined tools will not strip fasteners, wear prematurely or damage delicate equipment to which repairs would be expensive and time consuming. Tool users can feel confident that Bondhus tools have the strength and precision to protect even their most delicate and expensive components.



**7) Tools work at up to a 25 degree angle (ball end tools)**

Working with a hex tool, near obstructions that block 360 degrees of handle rotation, can consume significant amounts of time. A standard hex or Star tool must be removed and reinserted with every rotation of the screw, and often, screws can only be turned a fraction of a rotation at a time.



Hex tool constantly removed and re-inserted

**Bondhus:** When using a Bondhus ball end tool, the time and effort of working in those difficult blind or hard to reach locations is greatly reduced. A Bondhus ball end can provide continuous rotation, eliminating the time-consuming need to constantly remove and reinsert the tool.



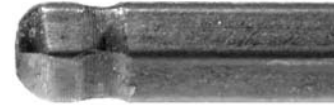
Ball end tool provides continuous rotation

Angle insertion of a screw requires a sensitive feel to know when the thread has been started straight. This is especially important when working with small screw sizes, or inserting screws into soft materials like aluminum or plastic, which are prone to cross-threading. Bondhus ball ends minimize the possibility of cross-threading by providing a full 360 degrees of smooth rotation and preserving rotational sensitivity.



# Screwdriver Tools

**Competitors:** An imprecisely machined ball end can deliver reduced working angle and can sacrifice smooth rotation, and in turn, not provide the sensitive feel necessary for starting a thread straight. Cross-threading can easily occur, and re-tapping a thread in a difficult location often requires time-consuming disassembly of equipment.



Competitor tool: Imprecise machining sacrifices smooth rotation

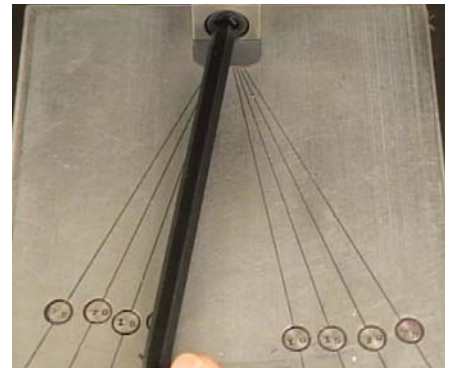
Some ball ends are not only poorly machined, they are also undersized. They can rotate smoothly only because of excessive clearance between the tip and socket walls, and give a misleading feel of precision. In just a short time, they will wear excessively, and stripping of the ball end or screw head will be the outcome.



Competitor tool: Imprecise machining causes undersized tips

## 8) Superior ball end strength and working angle

“Working angle” is the maximum angle at which a ball end can operate smoothly, while fully seated in the screw head. A quality ball end tool must provide good working angle without compromising neck strength. Bondhus ball end tools are designed to deliver a full 25 degrees of working angle, while delivering maximum neck strength.



Competitor tool: Thick neck limits working angle to only 9°

**Competitors:** Competitors manufacture ball ends from common grades of steel that lack the strength of Bondhus Protanium® Steel. To compensate for inadequate strength, some manufacturers *increase* neck size. As neck size increases, however, working angle *decreases*. Strength is improved, but working angle becomes inadequate.

To achieve working angles up to 35°, some manufacturers *reduce* neck size. Reduced neck size decreases strength, and as the recommended seating torque for the screw is approached, the risk of breakage increases. A broken tip can mean a substantial loss of time if the broken ball end jams itself in the screw head or damages the screw head.

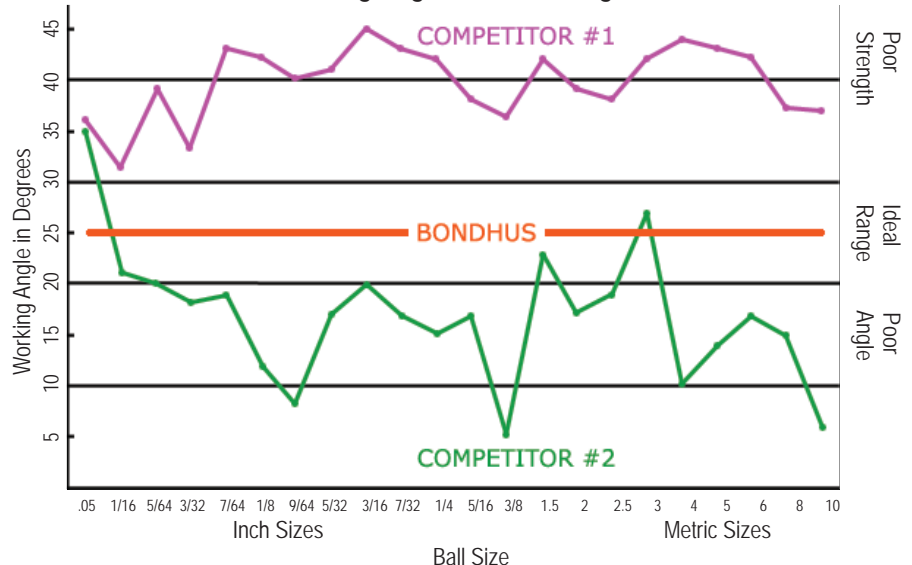


Competitor tool: Thin neck size risks breakage

**Bondhus:** Bondhus ball end tools achieve the ideal balance between working angle and strength. The strength of Protanium® Steel allows a neck size that delivers a full 25 degrees of working angle, while maintaining superior strength and wear resistance.

A blade with a hex tip begins to yield when maximum torque is reached. The tool user can easily feel that yield, and by not applying additional torque, breakage can be avoided. In contrast, a ball end tip provides no warning of impending breakage to the tool user. When over-torqued, it breaks without warning. This is one of the reasons why the strength of a Protanium® Steel ball end is such an important feature.

Ball End Comparison Working Angle Versus Strength



8

# Screwdriver Tools

## 9) Funnel insertion

Bondhus ball ends insert smoothly and are faster and easier to insert into a screw head than a hex tip. The concept by which the ball end channels itself into a screw head is known as funnel insertion. Precise design and machining ensure that the sides of the ball funnel the tip into the screw head and seat to full depth.



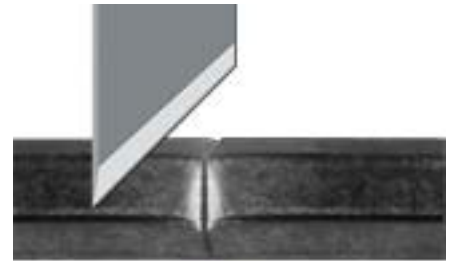
## 10) Chamfered tool tips (short arm on ball end hex keys)

**Bondhus:** Bondhus uses a precise method of cutting, and then chamfers tips to eliminate any possibility of burrs. The chamfering makes insertion of a straight hex or Star tip into a screw head much easier. Bondhus employs several styles of chamfers, using each style where it is most effective. The type of chamfer used is not critical. The point is to ensure burrs are removed from all hex and Star keys. Bondhus hex and Star tips always insert smoothly and seat to full depth for optimal torque and longer tool life.

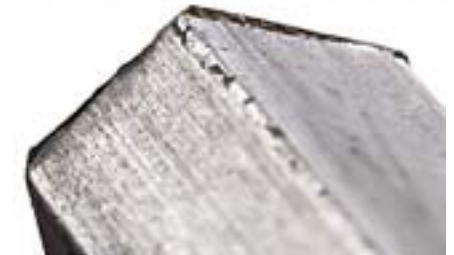


Chamfered Bondhus tip

**Competitors:** Imprecise methods of cutting produce burrs on the tips of hex and Star keys. It is common for burrs to be so large, they need to be filed away before the tool will insert into a screw head.



The clearance between a hex key and the screw walls is typically .0005" (.0127mm) or less on each side of the key, and even a very small burr can interfere with or prevent insertion. If the socket of a screw head is on the small side of its tolerance, and the hex key is on the large side of its tolerance, any amount of burr will prevent proper insertion of the tip into the screw head.



Competitor: Imprecise cutting causes burrs on tips

Competitor tools often feel snug in a screw head when first used, and then feel loose after only a couple of uses. The reason this happens is their tips often contain burrs. The burrs make the tool initially feel snug, but as soon as they wear off, the tips loose fit becomes obvious, and it proceeds to wear both the tool tip and the screw head quickly.

An imprecise cutting process can also distort the tool tip, causing it to be undersized, and to be slightly bent. Even chamfering or filing will not correct a problem of this severity.



Competitor: Tip bent by cutting process

As a last consideration, the cutting process can produce what is known as lips on the tip of a tool. Protrusions of this nature will prevent the tip from seating to the full depth in the screw head, thus increasing wear and the potential for stripping both the tool and the screw head.



Competitor: Tip with lips will not seat to full depth

# Screwdriver Tools

## 11) Precise machining

**Bondhus:** Professional tool users recognize the Bondhus name as synonymous with quality, consistency and reliability. Bondhus is meticulous about quality and the enforcement of the tightest specifications in the hex and Star tool industry. Every tool Bondhus manufactures is subject to its own set of specifications and a company policy of no exceptions or deviations. Specifications are enforced by quality assurance testing at every stage of the manufacturing process.

Precision machining is critical for a ball end tool to function optimally. Understandably, the smaller a ball end tip is, the more complex the task of machining becomes.

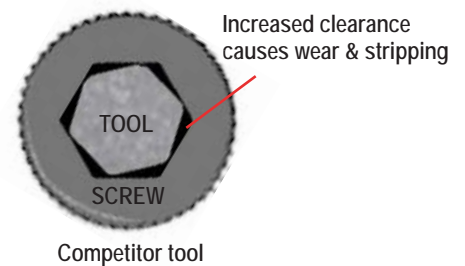
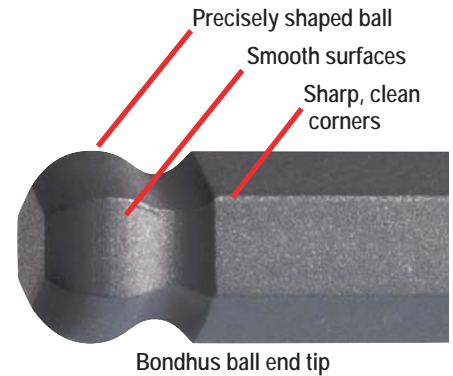
Bondhus maintains incredibly tight tolerances and close clearances between ball end tips and the screw head walls. Bondhus machining accurately maintains the precise geometric shape of the ball on all six sides. Surfaces are smooth, and corners are sharp and clean, even on a tool as small as .050" (1.27mm).

Precise machining results in Bondhus ball end tips having more surface area contacting the screw walls than any other competitor. Bondhus ball end tools far outwear the competition, and dramatically reduce stripping. Fastener wear is also greatly reduced.

**Competitors:** Claims of quality and precision are also made by competitors who often represent their tools as "comparable", "nearly comparable" or "good enough" when compared to Bondhus tools. Bondhus encourages head-to-head comparison and is pleased to provide all the information necessary for professional tool users to make their own informed decisions.

The ball end to the right is so poorly machined, it cannot even hold a screw in a horizontal position. Working in a blind or difficult location would be nearly impossible with this poorly machined tool tip.

Poorly machined ball ends do not just compromise working angle. Imprecise machining can cause tips to be under-sized and not symmetrical. The clearance between the tip and screw walls increases, causing excessive wear and stripping.



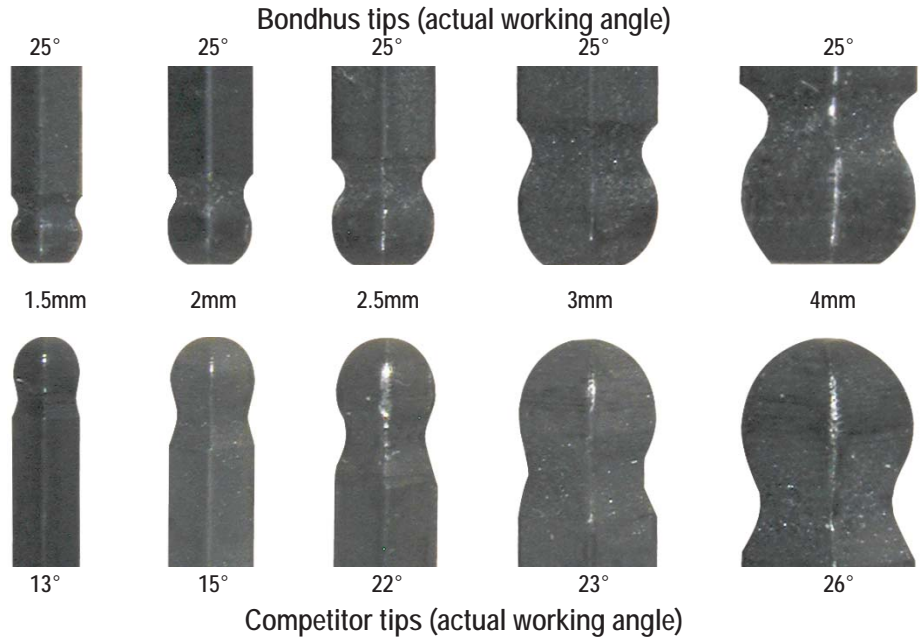
# Screwdriver Tools

## 12) Consistent 25 degree working angle on ball end tools

**Bondhus:** Bondhus ball end tips are precisely machined to provide a consistent 25 degrees of working angle, regardless of how large or small the tool is.

**Competitors:** Comparing Bondhus ball ends to those of a well known competitor, the differences are quite dramatic. Wide tolerances and imprecise machining cause many competitor ball ends to have an irregular ball shape. Wide variations in working angle from one tool to the next is the result, with some tools having less than 15° of working angle.

The competitor who manufactures these tools claims a 30° working angle. Actual measurement though, showed large inconsistencies from one tool to the next, and none were capable of reaching 30°.



## 13) Handles matched to tip torque (screwdrivers and T-Handles)

**Bondhus:** A screwdriver is capable of over-torquing its blade and can easily result in damage to the tool. Bondhus is the only manufacturer to design handles matched to the torque capacity of their blades and tips. Whether using a hex, Star or ball end tip, tool users can feel confident that applying torque will not result in breakage or damage to a Bondhus screwdriver.



A T-Handle that is too large can easily generate too much torque and risk blade or tip damage. A T-Handle that is too small requires wasted effort to generate required torque, resulting in needless user fatigue. The handles on all Bondhus T-Handles are sized to strike a balance between ease of use and protection against tool damage. Handles are large enough to easily and comfortably generate needed torque, yet small enough to help prevent accidental over-torquing that could damage the blade or tip.

Bondhus does not manufacture ball end T-Handles in sizes smaller than 5/32" and 4mm. A T-Handle could easily over-torque and break smaller size ball end tips. *Hex tips* are provided on tools of these sizes, in order to prevent tip damage.

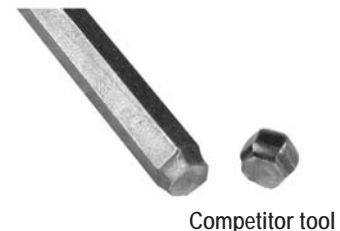
Inch	Metric
3/32"	2mm
7/64"	2.5mm
1/8"	3mm
9/64"	

T-Handles with hex tips

**Competitors:** Many screwdriver and T-Handle tools are available with handles that far exceed the torque capacity of their blades or tips. Damage and breakage, caused by over-torquing, is common to these tools.



A handle this large, is capable of generating more torque than this ball end tip can deliver. Without warning, the tip can easily be broken off.



# Screwdriver Tools

## 14) Worlds strongest tools -Protanium® Steel

### ► Protanium® High Torque Steel - a custom blended steel

Protanium® Steel is much more than “just steel” and much more than a “name”. It is a commitment to producing a level of tool performance unmatched by any competitor. Protanium® High Torque Steel is not an 8650 grade of steel, it is not a form of S-2 and it is not a chrome-vanadium or chrome-moly type of steel. Protanium® High Torque Steel is custom mixed to a formula that is the result of many years of research and continuous development efforts. Bondhus’ customized heat treating processes are the key to bringing out the superior strength properties of Protanium® High Torque Steel. Attaining results that push beyond the accepted limits of performance requires the skill and years of research and development that Bondhus alone has committed itself to.

(For more in-depth information on Protanium® Steel, please refer to Section 1 on pages 1 - 16.)

### Custom blended steel versus common grades of steel

In the broadest possible terms, only two categories of steel are used in the manufacturing of hex and Star tools; custom blended steel and standard grades of steel. A simple comparison makes it easy to see why Bondhus custom blended Protanium® Steel achieves far greater levels of performance than standard grades of steel:

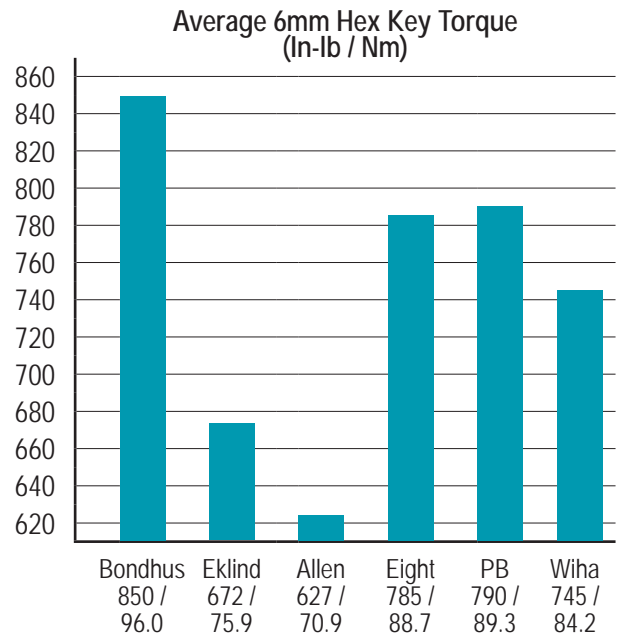
Custom blended Protanium® Steel	Standard grades of steel
A custom blend specifically designed for the rigors and requirements of hex and Star tools	Standard grades of steel are a one-size-fits-all solution, designed for a range of uses, not just hex and Star tools
The elements making up the steel's composition and the process used to produce the steel are customized to the Protanium® Steel specification, enabling use of customized heat treating processes that produce tools with greater hardness and ductility	The tool manufacturer has no control over the steel's blend. Heat treating cannot be customized beyond the limitations of the standard blend
Imperfections are eliminated through the addition of specific elements and by controlling the methods by which mills produce the steel	Tool manufacturer has no control over the steel's production or imperfections that may result
Meticulous quality control, monitoring and documentation are enforced by the Protanium® Steel specification	Steel mills perform their own “standard” quality control
The drawing process is controlled to produce stock with highly precise dimensional accuracy, sharp corners and smooth clean surfaces	Tool manufacturer has little control over drawing process



# Screwdriver Tools

Except for Bondhus, all other hex and Star tool manufacturers use various standard grades of steel in the manufacturing of their tools:

- 8650 is the most common grade in use throughout the U.S. and Asia. It does not achieve the hardness or ductility levels of Protanium® steel.
- Chrome Vanadium is comparable in performance to 8650. It is used primarily in Europe.
- Chrome Moly is similar to Chrome Vanadium, but is somewhat stronger and harder. Because it is fairly expensive, manufacturers generally only use it on their higher priced tools like ball end products, and substitute lower grades for their hex and folding tools. Europe and Japan are the primary users.
- S2 is used by only a small number of manufacturers. It is harder than 8650, but it is also less ductile, more costly, and far more prone to shattering.
- Carbon steel grades, such as 1050, are low-grade steels that are inferior to those listed above. They are still used by some manufacturers in Europe and Asia.



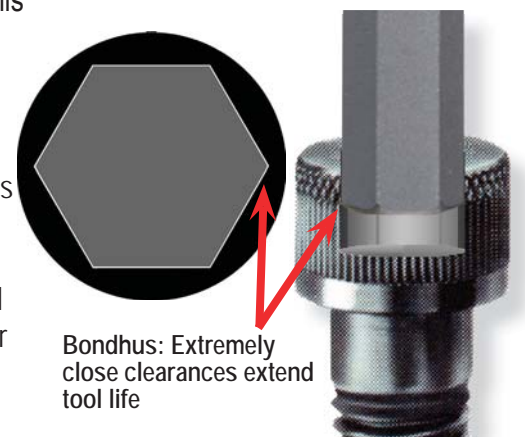
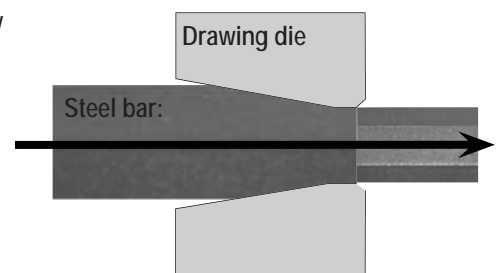
## ► *Bondhus controlled steel drawing process*

Changing the size or shape of a metal bar or rod by pulling it through a die is known as drawing. It is a critical process in the production of high quality steel, since it determines the dimensional precision and surface quality of the steel.

Standard grades of steel are drawn to tolerances that do not conform to the Protanium® Steel specification for precision, so Bondhus exercises full control over the drawing process. Bondhus works closely with its' steel suppliers to ensure 100% compliance with the Protanium® Steel drawing specification, and will not work with any mill unwilling to make this commitment.

### Close clearances

Tolerances imposed by the Protanium® Steel drawing specification produce stock so precisely drawn that clearances between a Bondhus tool tip and the screw walls is typically one half thousandth of an inch or less. Clearances this close produce tool tips with greater surface area contacting the screw walls. Smaller clearances between the tool surface and the screw head mean Bondhus tools greatly reduce wear of tool tips and screw heads, and reduce or eliminate the potential of stripping.





# Screwdriver Tools

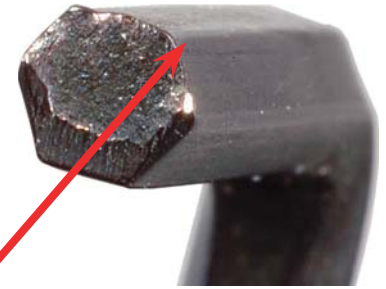
## Sharp corners

Another requirement of the Protanium® Steel drawing specification is that corners be sharp and smooth. Eliminating gaps between the tool tip corners and the screw walls means tool tip surface area increases. Tool tip and screw head wear is greatly reduced, since the primary cause of screw stripping has been eliminated.



Bondhus: Sharp, clean corners

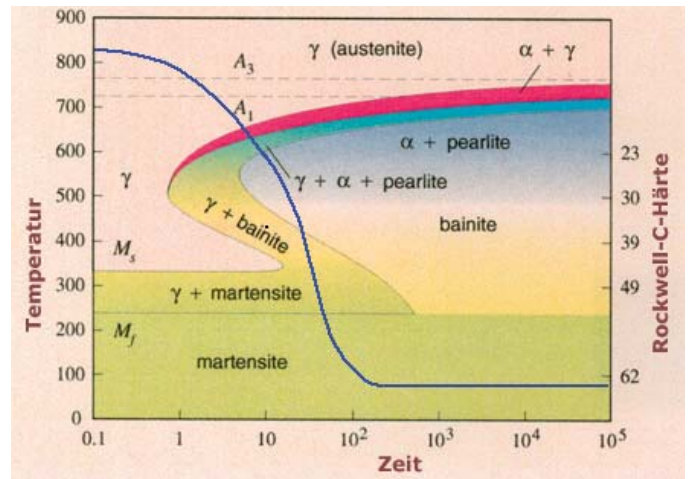
Standard grades of steel allow far more rounding of corners during the drawing process and surfaces that are not nearly as smooth, so the process of tool wear and screw stripping is accelerated. Once again, tools made with standard grades of steel perform inconsistently and unreliably.



Competitors: Rounded corners accelerate wear and stripping

## ► Customized heat treating process assures optimal combination of hardness and ductility

Heat treating is a series of processes where steel is heated to a temperature referred to as its *transformation point*, where its atomic structure actually changes. It is then cooled (quenched) in a highly controlled process where it is held at a specific *temperature* for a precise period of *time*. Complex documents known as TTT Charts (Time / Temperature / Transform) show this relationship. They assist in determining an optimal heating and quenching cycle for obtaining desired properties such as optimal microstructure, grain size, hardness and ductility.



Sample TTT chart

## Truly customized heat treating

An essential point to understand about heat treating is that the blend of the steel largely determines how and to what extent desired properties of the steel can be obtained in the heat treating process. In other words, controlling and customizing the blend of the steel is the only means by which truly customized heat treating can be accomplished. Protanium® Steel starts as a custom blended steel, and is transformed into hard, ductile tools by customized heat treat processes.

- Competitors must perform their heat treating to accommodate the limitations of the standard grades of steel they purchase. Since they have no control over the blend of the steel, their heat treating cannot achieve the levels of hardness and ductility achieved by Protanium® Steel.
- Bondhus continually improves the blend of Protanium® Steel to achieve full customization of the heat treating process. With full control of the steel's blend and its heat treating, Protanium® Steel is capable of achieving levels of hardness and ductility well beyond the limitations of the standard grades of steel used by competitors

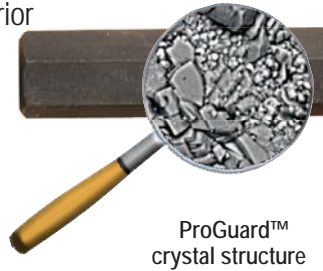


# Screwdriver Tools

## 15) Worlds best corrosion protection - ProGuard™ Dry Surface Technology

### ► ProGuard™ surface is impermeable to moisture and contaminants

ProGuard™ dry surface protection represents a dramatic improvement over traditional methods of protecting hex and Star tools. The ProGuard™ crystal structure provides a superior barrier against elements that cause rust and corrosion. It protects the tool for a lifetime of use and keeps tools looking attractive.



ProGuard™ crystal structure

Independent lab testing has proven ProGuard™ finish is up to five times more effective than alternative finishes offered by competitors.

### ► Finish is dry and clean with a final light coating of oil

**Bondhus:** The ProGuard™ finish locks out moisture and contaminants without the ongoing requirement of an oily surface. ProGuard™ tools receive a light coat of oil prior to packaging, but do not rely on oil as their primary means of protection. Tool user's hands and work areas remain dry and clean.

**Competitors:** Tools with inadequate protection rely on the user to keep the surface sealed with oil. Tools are dirty, messy and unpleasant to work with, and corrosion protection still remains inadequate.

### ► ProGuard™ finish is permanently bonded to surface of tool

**Bondhus:** ProGuard™ protection is a proprietary finish only available on Bondhus tools. It provides a permanent finish that cannot be wiped off like a black oxide or oil finish.

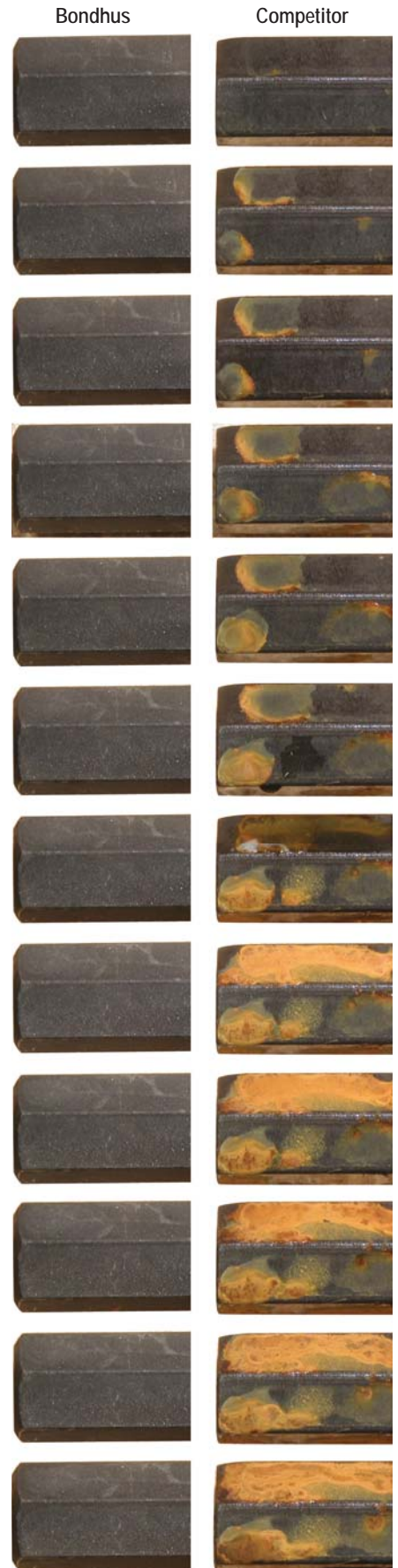
Application of the ProGuard™ finish starts with a thorough caustic cleaning of the tool's surface. A small grained crystal structure is then permanently bonded to the entire surface of the tool through a ten step process. The resulting tight structure makes it very difficult for moisture and contaminants to penetrate the surface.

Smooth surfaces and sharp corners provide further protection to Bondhus tools by denying moisture and contaminants places to collect.



Bondhus tool

## 12 hour time-lapse moisture test sequence

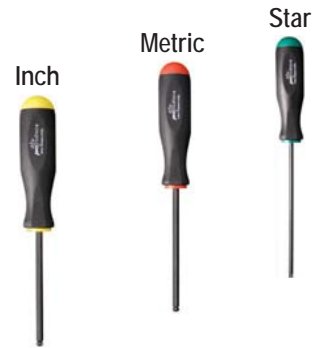


# Screwdriver Tools

## 16) Color coded handles

Color coding of Bondhus handles makes inch, metric and Star tools easy to identify and distinguish from one another.

Inch	-	yellow
Metric	-	red
Star	-	green



## 17) Lifetime warranty

Bondhus manufactures the highest quality hex and Star tools available, and every tool is backed by an unconditional lifetime warranty.

*"All Bondhus products are guaranteed for life. If you are not satisfied with a Bondhus tool - for any reason - simply return it. A replacement will be shipped right out at no cost - no hassles, no questions asked."*

A warranty is only as good as the company standing behind it. Bondhus has been the leading innovator in the hex and Star tool industry for over forty years.



## 18) ProGuard™ (black) and BriteGuard™ (chrome) finishes

Bondhus offers tool users the choice of two different types of corrosion protection for Stubby tools. ProGuard™ protection is the most effective solution available, and is available on all Bondhus tools. For tool users who prefer a plated finish, BriteGuard™ protection provides a traditional chrome finish.



# Screwdriver Tools

## Frequently Asked Questions

*When should I use a ball end screwdriver? What are they designed for?*

The primary advantage of a ball end screwdriver is speed. A ball end screwdriver can turn a screw very quickly.

*Why are there different sized handles?*

The handles on Bondhus screwdrivers and T-Handles are specially sized to protect the tool tips against breakage. The torque capacity of these handles are closely matched to the torque capacity of their associated tips. Competitor tools with large handles, can easily cause breakage due to the ease with which their handles can over torque their tips.

# Stubby Tools

Bondhus Stubby tools are designed and manufactured to be strong, to save time and to fit into low overhead locations that are too short for a standard hex or Ball End wrench. The low profile short arm has a smaller inside radius that allows the tool to be used in very tight spaces. All Bondhus Stubby tools also have the exclusive Bondhus Ball End on the long arm of the tool. Bondhus invented the Ball End tip for use with socket screws and has achieved the ideal combination of angle and strength. Bondhus Ball Ends rotate smoothly in a screw head at 25 degrees. Bondhus' exclusive manufacturing processes ensure the highest level of machining consistency as each Ball End is machined to incredibly tight tolerances. All Bondhus Stubby tools are manufactured with Bondhus' exclusive Protanium® Steel, which is up to 20% stronger than competitor tools, and are available in many different corrosion protection finishes.



## Features

- 1) Low Profile short arm
- 2) Tighter inside radius than standard hex keys
- 3) This one tool works in regular as well as tight clearance applications.
- 4) Ball ends insert into screws at an angle
- 5) Stubby tools available for very small sizes:  
As small as .050" & 1.27mm
- 6) Tools work at a 25 degree angle (ball end tools)
- 7) Superior ball end strength and working angle
- 8) Funnel insertion (ball end tools)
- 9) Chamfered tool tips (short arm on ball end tools)
- 10) Precise machining
- 11) Consistent 25 degree working angle on ball end tools

## Benefits

- 1) Reaches screws with low overhead clearance, that are inaccessible with any other type of hex tool. Eliminates disassembly of equipment to gain access to the screw head.
- 2) Saves time because the tight radius design reaches screws that even a hex key with a cut down short arm cannot reach
- 3) Saves money because tool user needs only one tool for both regular and tight clearance applications
- 4) Saves time because tool user can reach and turn screws that cannot be reached straight-in
- 5) Bondhus' extremely precise manufacturing methods create tools that work well, even in very small sizes
- 6) Screws can be turned continuously, without constantly taking the tool out of the screw, repositioning it and reinserting it, even at angles up to 25 degrees.
- 7) Bondhus ball end tips are designed to be the perfect balance between angle and strength. Ball end strength is maximized, while still providing a consistent full 25 degrees of working angle.
- 8) Saves time because Bondhus ball ends automatically funnel themselves into the screw head and seat to full depth
- 9) Saves time because burrs that might prevent insertion of the tool tip into the screw head are completely removed, so tip insertion is quick and easy
- 10) Saves time because precision machining means every Bondhus tool will fit precisely into the screw head, minimizing breakage and stripping
- 11) Saves time because tool users can absolutely count on every Bondhus ball end tool to provide a full 25 degrees of working angle, period.

# Stubby Tools

## Features

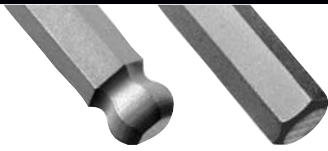
- 12) Worlds strongest tools - Protanium® Steel
- 13) Worlds best corrosion protection - ProGuard™ Dry Surface Technology
- 14) Color coded cases
- 15) Bondhex™ case
- 16) Lifetime warranty
- 17) ProGuard™ (black), BriteGuard™ (chrome) finishes

## Benefits

- 12) Saves time because Bondhus' exclusive Protanium® Steel makes Bondhus tools up to 20% stronger than competitor tools and allows the tool user to deliver more torque without breaking the tool or damaging the screw head.
- 13) Saves time because the tool user does not have to work with rusty tools. ProGuard™ protection delivers up to 5 times the corrosion resistance of any other hex or Star tool finish.
- 14) Saves time because the tool user can quickly identify inch (yellow) and metric (red) tools
- 15) Saves time because tools are neatly organized and locked in place to prevent loss. Tools are easily removed from the case with a slight twist of the tool.
- 16) Bondhus stands behind every sale with a "No questions asked" lifetime replacement policy
- 17) Tool users have a wide range of finish choices to fit virtually every need.

\* Bondhus, Bondhex, ProGuard, Protanium, Balldriver, BallStar, GorillaGrip, BriteGuard and GoldGuard are trademarks of Bondhus Corporation.

# Stubby Tools



## 1) Low Profile short arm

The short arm length of a Bondhus Stubby tool is considerably shorter than that of a standard hex key. As a result, a Stubby tool can be used in locations where clearance is too tight for an ordinary hex key and the angle of insertion would be too great for a ball end tool.

Prior to the introduction of the Stubby hex key, extracting screws from low clearance areas often meant disassembling equipment to provide access to the screw heads. Stubby tools can eliminate the need for disassembly, saving valuable time.

The picture to the right shows an actual situation where a standard hex or ball end tool could not access a critical screw. Disassembly would have been time consuming, but instead, the low clearance of the Stubby tool provided the necessary access for easy extraction of the screw.



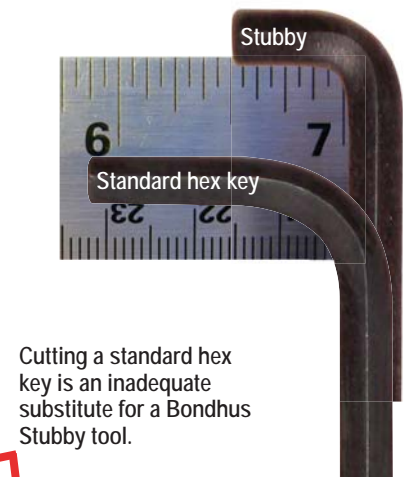
Not enough overhead clearance for standard hex key

## 2) Tighter inside radius than standard hex keys

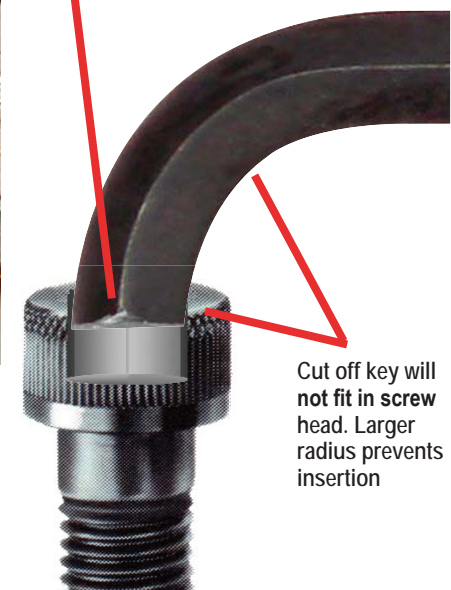
A Stubby tool is more than a hex key with a reduced length short arm. The low profile of a Stubby tool is made effective by its tight radius. Cutting down a standard hex key is no substitute for a Bondhus Stubby tool, and it has several shortcomings. Burrs created on the tip need to be filed off.

Only a Bondhus Stubby tool insures the full hardness and strength of the short arm. "Field cutting" of a standard key will almost always result in a softer tool tip and increased chance of damage to the screw head.

If the short arm of a standard hex key is cut to the length of a Stubby short arm, the tip will include a slight bend, due to the wider radius bend of the hex key. That bend is enough to prevent smooth entry into a screw head and prevent the tip from seating to full depth.



Cutting a standard hex key is an inadequate substitute for a Bondhus Stubby tool.



Cut off key will not fit in screw head. Larger radius prevents insertion

## 3) This one tool works in regular as well as tight clearance applications.

Bondhus Stubby tools are designed with a hex tip on the short arm and a ball end on the long arm. Since they provide all the features of a standard hex key, they can be used as a replacement for standard hex and ball end keys.

# Stubby Tools

**4) Ball ends insert into screws at an angle** Bondhus ball end tools are tremendous time savers. A hex or Star tip tool can only be inserted in a screw head from a straight-on direction (0 degrees), but a Bondhus ball end tip can enter from any angle up to 25 degrees, and insertion is quick and easy. The need to disassemble equipment to provide tool access to a screw head can be reduced or eliminated.

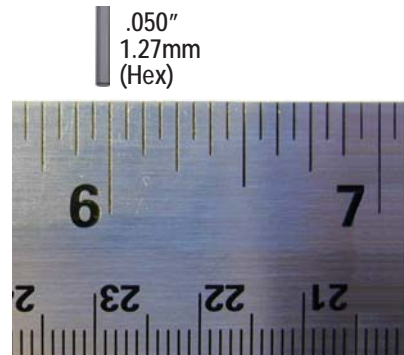


**5) Stubby tools available for very small sizes:**

*As small as .050" & 1.5mm*

Bondhus manufactures a broad selection of ball end hex and ball end Star tools for precision applications. Even in these incredibly small sizes, Bondhus tools maintain tight tolerances, highly precise machining and absolute consistency.

Bondhus precision machined tools will not strip fasteners, wear prematurely or damage delicate equipment to which repairs would be expensive and time consuming. Tool users can feel confident that Bondhus tools have the strength and precision to protect even their most delicate and expensive components.



**6) Tools work at up to a 25 degree angle (ball end tools)**

Working with a hex or Star tool, near obstructions that block 360 degrees of handle rotation, can consume significant amounts of time. A standard hex or Star tool must be removed and reinserted with every rotation of the screw, and often, screws can only be turned a fraction of a rotation at a time.



Hex tool constantly removed and re-inserted

**Bondhus:** When using a Bondhus ball end tool, the time and effort of working in those difficult blind or hard to reach locations is greatly reduced. A Bondhus ball end can provide continuous rotation, eliminating the time-consuming need to constantly remove and reinsert the tool.



Ball end tool provides continuous rotation

Angle insertion of a screw requires a sensitive feel to know when the thread has been started straight. This is especially important when working with small screw sizes, or inserting screws into soft materials like aluminum or plastic, which are prone to cross-threading. Bondhus ball ends minimize the possibility of cross-threading by providing a full 360 degrees of smooth rotation and preserving rotational sensitivity.





# Stubby Tools

**Competitors:** An imprecisely machined ball end can deliver reduced working angle and can sacrifice smooth rotation, and in turn, not provide the sensitive feel necessary for starting a thread straight. Cross-threading can easily occur, and re-tapping a thread in a difficult location often requires time-consuming disassembly of equipment.



Competitor tool: Imprecise machining sacrifices smooth rotation

Some ball ends are not only poorly machined, they are also undersized. They can rotate smoothly only because of excessive clearance between the tip and socket walls, and give a misleading feel of precision. In just a short time, they will wear excessively, and stripping of the ball end or screw head will be the outcome.

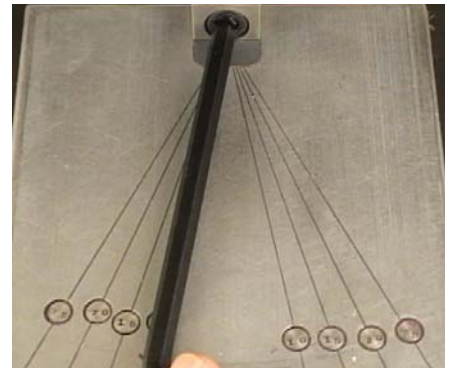


Competitor tool: Imprecise machining causes undersized tips

## 7) Superior ball end strength and working angle

“Working angle” is the maximum angle at which a ball end can operate smoothly, while fully seated in the screw head. A quality ball end tool must provide good working angle without compromising neck strength. Bondhus ball end tools are designed to deliver a full 25 degrees of working angle, while delivering maximum neck strength.

**Competitors:** Competitors manufacture ball ends from common grades of steel that lack the strength of Bondhus Protanium® Steel. To compensate for inadequate strength, some manufacturers *increase* neck size. As neck size increases, however, working angle *decreases*. Strength is improved, but working angle becomes inadequate.



Competitor tool: Thick neck limits working angle to only 9°

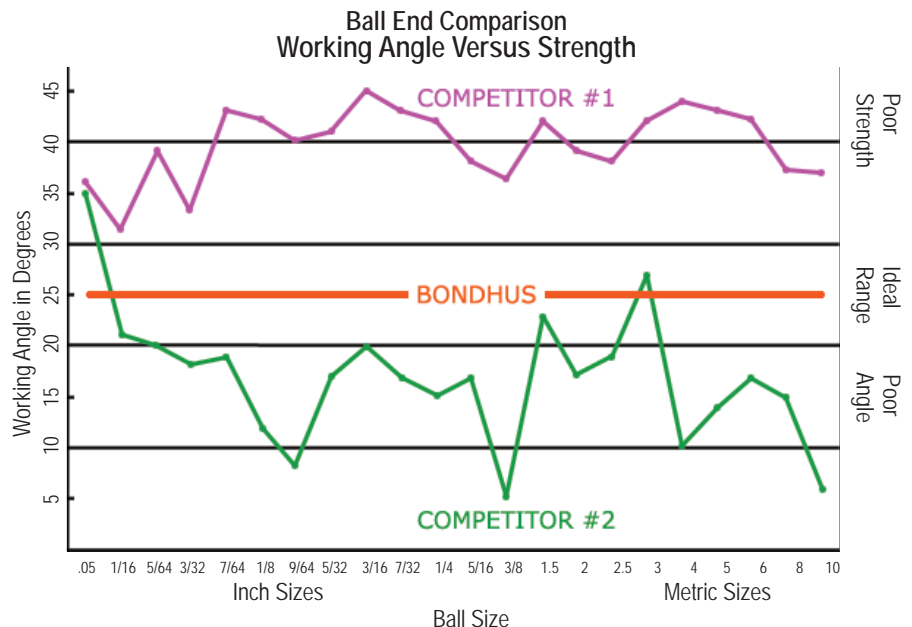
To achieve working angles up to 35°, some manufacturers *reduce* neck size. Reduced neck size decreases strength, and as the recommended seating torque for the screw is approached, the risk of breakage increases. A broken tip can mean a substantial loss of time if the broken ball end jams itself in the screw head or damages the screw head.



Competitor tool: Thin neck size risks breakage

**Bondhus:** Bondhus ball end tools achieve the ideal balance between working angle and strength. The strength of Protanium® Steel allows a neck size that delivers a full 25 degrees of working angle, while maintaining superior strength and wear resistance.

A blade with a hex tip begins to yield when maximum torque is reached. The tool user can easily feel that yield, and by not applying additional torque, breakage can be avoided. In contrast, a ball end tip provides no warning of impending breakage to the tool user. When over-torqued, it breaks without warning. This is one of the reasons why the strength of a Protanium® Steel ball end is such an important feature.



# Stubby Tools

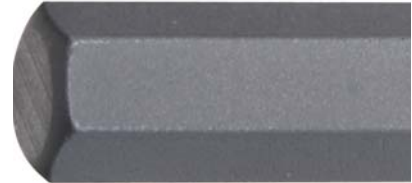
## 8) Funnel insertion

Bondhus ball ends insert smoothly and are faster and easier to insert into a screw head than a hex tip. The concept by which the ball end channels itself into a screw head is known as funnel insertion. Precise design and machining ensure that the sides of the ball funnel the tip into the screw head and seat to full depth.



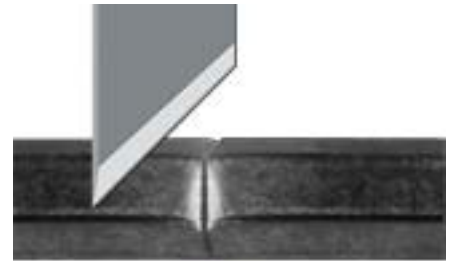
## 9) Chamfered tool tips (short arm on ball end hex keys)

**Bondhus:** Bondhus uses a precise method of cutting, and then chamfers tips to eliminate any possibility of burrs. The chamfering makes insertion of a straight hex or Star tip into a screw head much easier. Bondhus employs several styles of chamfers, using each style where it is most effective. The type of chamfer used is not critical. The point is to ensure burrs are removed from all hex and Star keys. Bondhus hex and Star tips always insert smoothly and seat to full depth for optimal torque and longer tool life.

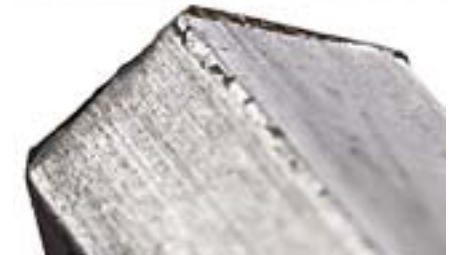


Chamfered Bondhus tip

**Competitors:** Imprecise methods of cutting produce burrs on the tips of hex and Star keys. It is common for burrs to be so large, they need to be filed away before the tool will insert into a screw head.



The clearance between a hex key and the screw walls is typically .0005" (.0127mm) or less on each side of the key, and even a very small burr can interfere with or prevent insertion. If the socket of a screw head is on the small side of its tolerance, and the hex key is on the large side of its tolerance, any amount of burr will prevent proper insertion of the tip into the screw head.



Competitor: Imprecise cutting causes burrs on tips

Competitor tools often feel snug in a screw head when first used, and then feel loose after only a couple of uses. The reason this happens is their tips often contain burrs. The burrs make the tool initially feel snug, but as soon as they wear off, the tips loose fit becomes obvious, and it proceeds to wear both the tool tip and the screw head quickly.

An imprecise cutting process can also distort the tool tip, causing it to be undersized, and to be slightly bent. Even chamfering or filing will not correct a problem of this severity.



Competitor: Tip bent by cutting process

As a last consideration, the cutting process can produce what is known as lips on the tip of a tool. Protrusions of this nature will prevent the tip from seating to the full depth in the screw head, thus increasing wear and the potential for stripping both the tool and the screw head.



Competitor: Tip with lips will not seat to full depth

# Stubby Tools

## 10) Precise machining

**Bondhus:** Professional tool users recognize the Bondhus name as synonymous with quality, consistency and reliability. Bondhus is meticulous about quality and the enforcement of the tightest specifications in the hex and Star tool industry. Every tool Bondhus manufactures is subject to its own set of specifications and a company policy of no exceptions or deviations. Specifications are enforced by quality assurance testing at every stage of the manufacturing process.

Precision machining is critical for a ball end tool to function optimally. Understandably, the smaller a ball end tip is, the more complex the task of machining becomes.

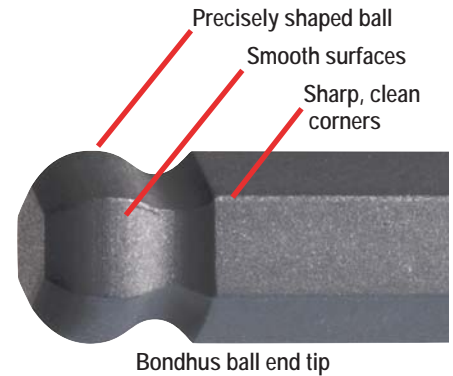
Bondhus maintains incredibly tight tolerances and close clearances between ball end tips and the screw head walls. Bondhus machining accurately maintains the precise geometric shape of the ball on all six sides. Surfaces are smooth, and corners are sharp and clean, even on a tool as small as .050" (1.27mm).

Precise machining results in Bondhus ball end tips having more surface area contacting the screw walls than any other competitor. Bondhus ball end tools far outwear the competition, and dramatically reduce stripping. Fastener wear is also greatly reduced.

**Competitors:** Claims of quality and precision are also made by competitors who often represent their tools as "comparable", "nearly comparable" or "good enough" when compared to Bondhus tools. Bondhus encourages head-to-head comparison and is pleased to provide all the information necessary for professional tool users to make their own informed decisions.

The ball end to the right is so poorly machined, it cannot even hold a screw in a horizontal position. Working in a blind or difficult location would be nearly impossible with this poorly machined tool tip.

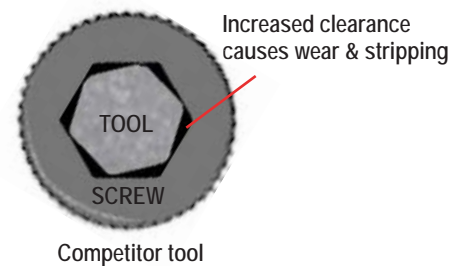
Poorly machined ball ends do not just compromise working angle. Imprecise machining can cause tips to be under-sized and not symmetrical. The clearance between the tip and screw walls increases, causing excessive wear and stripping.



9



Competitor tool



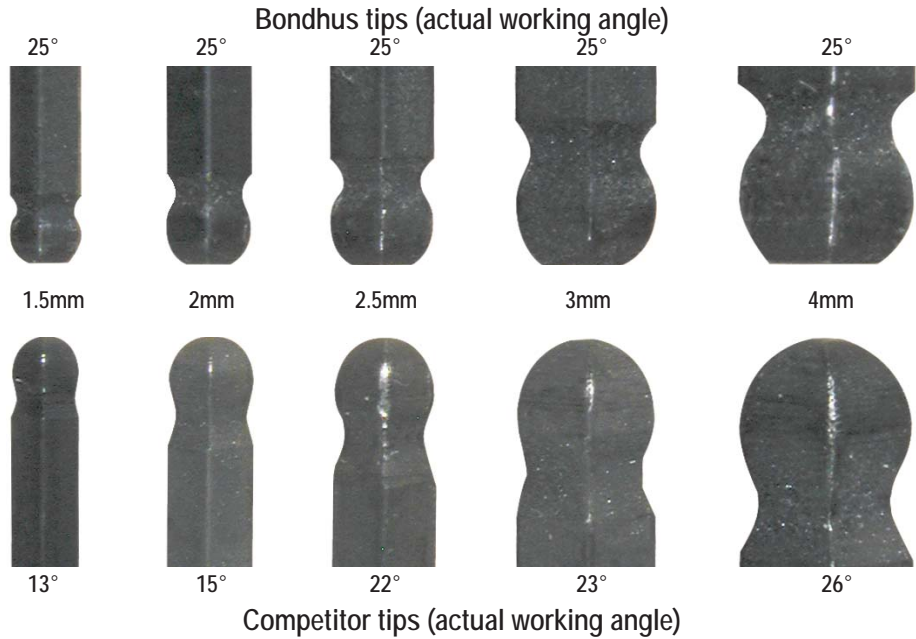
# Stubby Tools

## 11) Consistent 25 degree working angle on ball end tools

**Bondhus:** Bondhus ball end tips are precisely machined to provide a consistent 25 degrees of working angle, regardless of how large or small the tool is.

**Competitors:** Comparing Bondhus ball ends to those of a well known competitor, the differences are quite dramatic. Wide tolerances and imprecise machining cause many competitor ball ends to have an irregular ball shape. Wide variations in working angle from one tool to the next is the result, with some tools having less than 15° of working angle.

The competitor who manufactures these tools claims a 30° working angle. Actual measurement though, showed large inconsistencies from one tool to the next, and none were capable of reaching 30°.



# Stubby Tools

## 12) Worlds strongest tools -Protanium® Steel

### ► Protanium® High Torque Steel - a custom blended steel

Protanium® Steel is much more than “just steel” and much more than a “name”. It is a commitment to producing a level of tool performance unmatched by any competitor. Protanium® High Torque Steel is not an 8650 grade of steel, it is not a form of S-2 and it is not a chrome-vanadium or chrome-moly type of steel. Protanium® High Torque Steel is custom mixed to a formula that is the result of many years of research and continuous development efforts. Bondhus’ customized heat treating processes are the key to bringing out the superior strength properties of Protanium® High Torque Steel. Attaining results that push beyond the accepted limits of performance requires the skill and years of research and development that Bondhus alone has committed itself to.

(For more in-depth information on Protanium® Steel, please refer to Section 1 on pages 1 - 16.)

### Custom blended steel versus common grades of steel

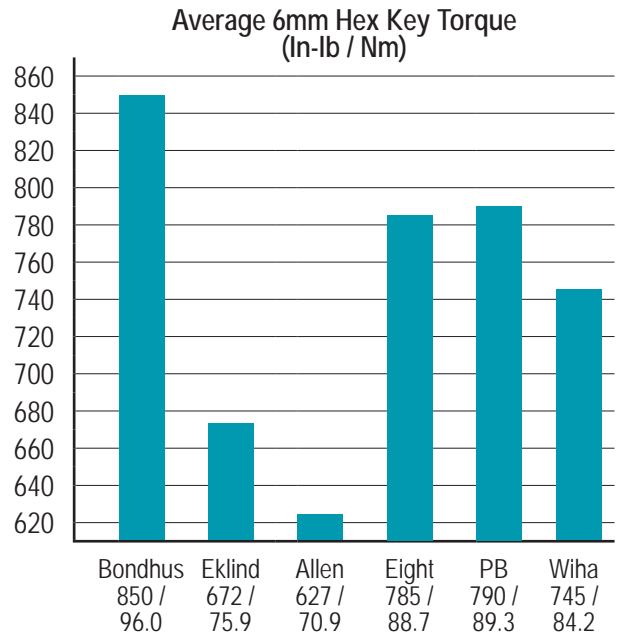
In the broadest possible terms, only two categories of steel are used in the manufacturing of hex and Star tools; custom blended steel and standard grades of steel. A simple comparison makes it easy to see why Bondhus custom blended Protanium® Steel achieves far greater levels of performance than standard grades of steel:

Custom blended Protanium® Steel	Standard grades of steel
A custom blend specifically designed for the rigors and requirements of hex and Star tools	Standard grades of steel are a one-size-fits-all solution, designed for a range of uses, not just hex and Star tools
The elements making up the steel's composition and the process used to produce the steel are customized to the Protanium® Steel specification, enabling use of customized heat treating processes that produce tools with greater hardness and ductility	The tool manufacturer has no control over the steel's blend. Heat treating cannot be customized beyond the limitations of the standard blend
Imperfections are eliminated through the addition of specific elements and by controlling the methods by which mills produce the steel	Tool manufacturer has no control over the steel's production or imperfections that may result
Meticulous quality control, monitoring and documentation are enforced by the Protanium® Steel specification	Steel mills perform their own “standard” quality control
The drawing process is controlled to produce stock with highly precise dimensional accuracy, sharp corners and smooth clean surfaces	Tool manufacturer has little control over drawing process

# Stubby Tools

Except for Bondhus, all other hex and Star tool manufacturers use various standard grades of steel in the manufacturing of their tools:

- 8650 is the most common grade in use throughout the U.S. and Asia. It does not achieve the hardness or ductility levels of Protanium® steel.
- Chrome Vanadium is comparable in performance to 8650. It is used primarily in Europe.
- Chrome Moly is similar to Chrome Vanadium, but is somewhat stronger and harder. Because it is fairly expensive, manufacturers generally only use it on their higher priced tools like ball end products, and substitute lower grades for their hex and folding tools. Europe and Japan are the primary users.
- S2 is used by only a small number of manufacturers. It is harder than 8650, but it is also less ductile, more costly, and far more prone to shattering.
- Carbon steel grades, such as 1050, are low-grade steels that are inferior to those listed above. They are still used by some manufacturers in Europe and Asia.



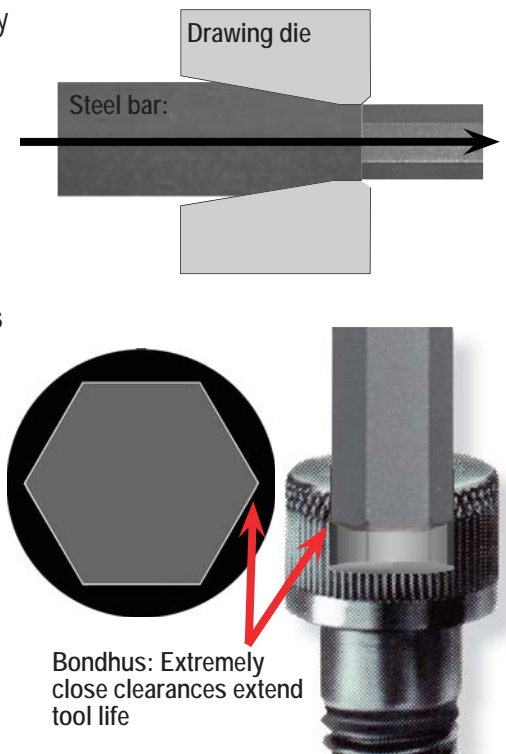
## ► *Bondhus controlled steel drawing process*

Changing the size or shape of a metal bar or rod by pulling it through a die is known as drawing. It is a critical process in the production of high quality steel, since it determines the dimensional precision and surface quality of the steel.

Standard grades of steel are drawn to tolerances that do not conform to the Protanium® Steel specification for precision, so Bondhus exercises full control over the drawing process. Bondhus works closely with its' steel suppliers to ensure 100% compliance with the Protanium® Steel drawing specification, and will not work with any mill unwilling to make this commitment.

### Close clearances

Tolerances imposed by the Protanium® Steel drawing specification produce stock so precisely drawn that clearances between a Bondhus tool tip and the screw walls is typically one half thousandth of an inch or less. Clearances this close produce tool tips with greater surface area contacting the screw walls. Smaller clearances between the tool surface and the screw head mean Bondhus tools greatly reduce wear of tool tips and screw heads, and reduce or eliminate the potential of stripping.



# Stubby Tools

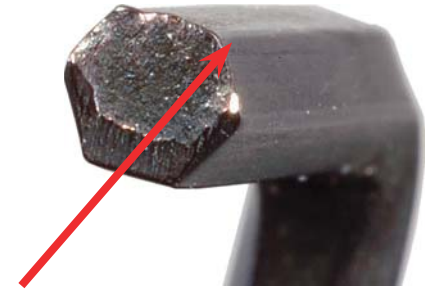
## Sharp corners

Another requirement of the Protanium® Steel drawing specification is that corners be sharp and smooth. Eliminating gaps between the tool tip corners and the screw walls means tool tip surface area increases. Tool tip and screw head wear is greatly reduced, since the primary cause of screw stripping has been eliminated.

Standard grades of steel allow far more rounding of corners during the drawing process and surfaces that are not nearly as smooth, so the process of tool wear and screw stripping is accelerated. Once again, tools made with standard grades of steel perform inconsistently and unreliably.



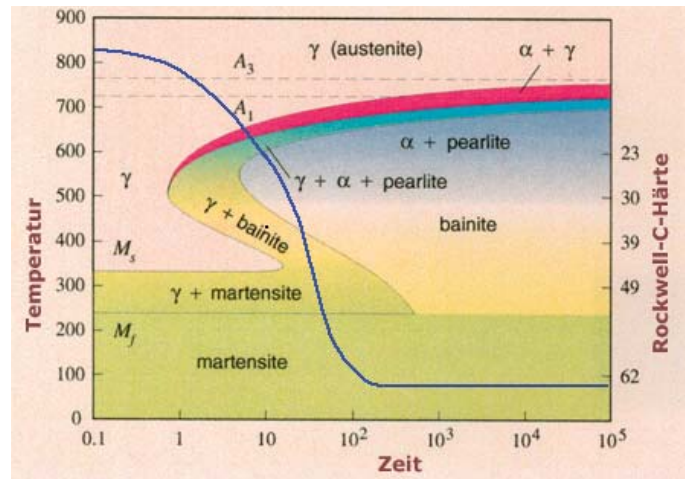
Bondhus: Sharp, clean corners



Competitors: Rounded corners accelerate wear and stripping

## ► Customized heat treating process assures optimal combination of hardness and ductility

Heat treating is a series of processes where steel is heated to a temperature referred to as its *transformation point*, where its atomic structure actually changes. It is then cooled (quenched) in a highly controlled process where it is held at a specific *temperature* for a precise period of *time*. Complex documents known as TTT Charts (Time / Temperature / Transform) show this relationship. They assist in determining an optimal heating and quenching cycle for obtaining desired properties such as optimal microstructure, grain size, hardness and ductility.



Sample TTT chart

## Truly customized heat treating

An essential point to understand about heat treating is that the blend of the steel largely determines how and to what extent desired properties of the steel can be obtained in the heat treating process. In other words, controlling and customizing the blend of the steel is the only means by which truly customized heat treating can be accomplished. Protanium® Steel starts as a custom blended steel, and is transformed into hard, ductile tools by customized heat treat processes.

- Competitors must perform their heat treating to accommodate the limitations of the standard grades of steel they purchase. Since they have no control over the blend of the steel, their heat treating cannot achieve the levels of hardness and ductility achieved by Protanium® Steel.
- Bondhus continually improves the blend of Protanium® Steel to achieve full customization of the heat treating process. With full control of the steel's blend and its heat treating, Protanium® Steel is capable of achieving levels of hardness and ductility well beyond the limitations of the standard grades of steel used by competitors

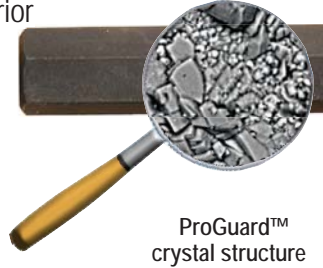


# Stubby Tools

## 13) Worlds best corrosion protection - ProGuard™ Dry Surface Technology

### ► ProGuard™ surface is impermeable to moisture and contaminants

ProGuard™ dry surface protection represents a dramatic improvement over traditional methods of protecting hex and Star tools. The ProGuard™ crystal structure provides a superior barrier against elements that cause rust and corrosion. It protects the tool for a lifetime of use and keeps tools looking attractive.



Independent lab testing has proven ProGuard™ finish is up to five times more effective than alternative finishes offered by competitors.

### ► Finish is dry and clean with a final light coating of oil

**Bondhus:** The ProGuard™ finish locks out moisture and contaminants without the ongoing requirement of an oily surface. ProGuard™ tools receive a light coat of oil prior to packaging, but do not rely on oil as their primary means of protection. Tool user's hands and work areas remain dry and clean.

**Competitors:** Tools with inadequate protection rely on the user to keep the surface sealed with oil. Tools are dirty, messy and unpleasant to work with, and corrosion protection still remains inadequate.

### ► ProGuard™ finish is permanently bonded to surface of tool

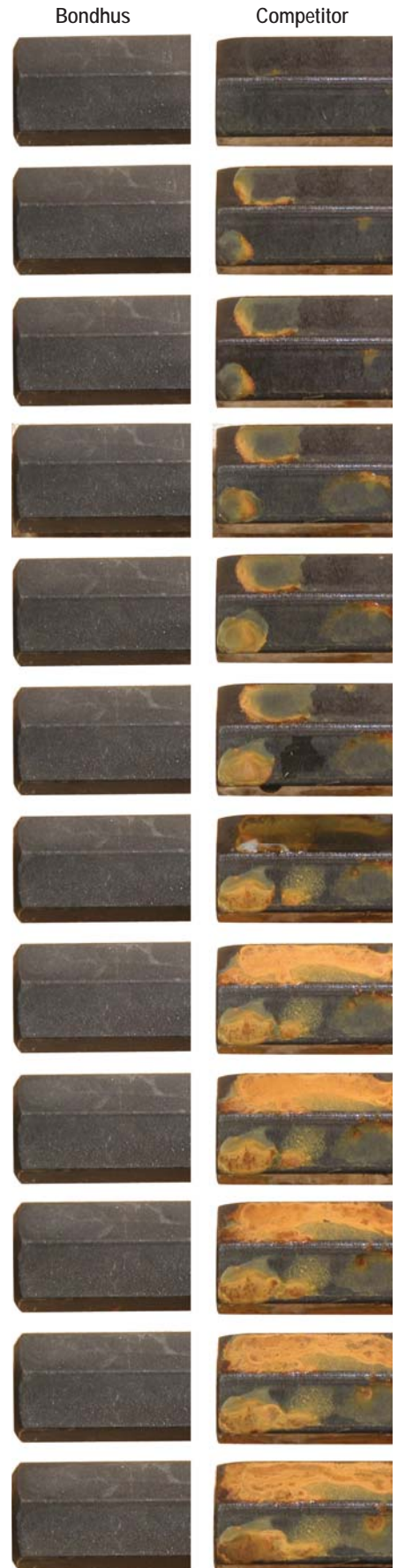
**Bondhus:** ProGuard™ protection is a proprietary finish only available on Bondhus tools. It provides a permanent finish that cannot be wiped off like a black oxide or oil finish.

Application of the ProGuard™ finish starts with a thorough caustic cleaning of the tool's surface. A small grained crystal structure is then permanently bonded to the entire surface of the tool through a ten step process. The resulting tight structure makes it very difficult for moisture and contaminants to penetrate the surface.

Smooth surfaces and sharp corners provide further protection to Bondhus tools by denying moisture and contaminants places to collect.



## 12 hour time-lapse moisture test sequence





# Stubby Tools

## 14) Color coded cases

Color coding of Bondhex™ cases makes inch and metric tools easy to identify and distinguish from one another.

Inch	-	yellow
Metric	-	red



## 15) Bondhex™ case

Bondhus ball end, hex and Star key sets include the color coded Bondhex™ case to keep tools neat and sorted. A simple 60 degree turn locks keys in place to eliminate loose, spilled and lost keys, and tool sizes are clearly printed beneath each tool for quick size selection. A Bondhex™ case can also be used with a hex key to increase grip and comfortably generate additional torque.



## 16) Lifetime warranty

Bondhus manufactures the highest quality hex and Star tools available, and every tool is backed by an unconditional lifetime warranty.

*"All Bondhus products are guaranteed for life. If you are not satisfied with a Bondhus tool - for any reason - simply return it. A replacement will be shipped right out at no cost - no hassles, no questions asked."*

A warranty is only as good as the company standing behind it. Bondhus has been the leading innovator in the hex and Star tool industry for over forty years.



## 17) ProGuard™ (black) and BriteGuard™ (chrome) finishes

Bondhus offers tool users the choice of two different types of corrosion protection for Stubby tools. ProGuard™ protection is the most effective solution available, and is available on all Bondhus tools. For tool users who prefer a plated finish, BriteGuard™ protection provides a traditional chrome finish.



# Stubby Tools

## Frequently Asked Questions

*Can stubby tools be used for the same applications as standard hex keys?*

Absolutely. Aside from the reduced length and smaller radius bend of the Stubby short arm, it is identical to a standard Bondhus ball end key. The reduced length short arm even makes the Stubby more stable than a standard hex key when applying high torque via the stubby short arm to a screw head.

*With a reduced length short arm, are Stubby tools weaker than standard hex keys?*

NO. A Stubby tool is identical in torque capacity to a standard Bondhus ball end key. A common misconception is that torque capacity is related to blade length. In reality, length has absolutely no effect on torque capacity, regardless of how long or short the blade might be.

# Star Tools

Bondhus Star tip tools are designed and manufactured to be strong and save time. Bondhus offers the widest variety of Star and Star plus tools so there is a Bondhus Star tool designed for virtually every possible application. Bondhus Star tools are available in T-handle, Screwdriver, L-wrench, Wing/Flag, Blade and Bit product categories with Star, Star Plus and BallStar™ tip types. Bondhus invented the Ball End Star tool (BallStar™ tip) which allows entry, exit and work within a fastener at angles up to 20 degrees. Bondhus' exclusive manufacturing processes ensure the highest level of machining consistency as each tool tip is machined to incredibly tight tolerances. All Bondhus Star tip tools are manufactured with Bondhus' exclusive Protanium® Steel, which is up to 20% stronger than competitor tools and finished with its' proprietary ProGuard™ corrosion resistant finish, which offers up to five times more corrosion protection than competitor finishes.



## Features

- 1) Large selection of Star tools
- 2) Star and Star Plus tools available
- 3) BallStar™ tips insert into screws at an angle (ball end tools)
- 4) Tools available for very small sizes:  
As small as T5 (Star)  
As small T6 (BallStar™ tip)
- 5) BallStar™ tools work at a 20 degree angle
- 6) Funnel insertion (ball end tools)
- 7) Chamfered tool tips
- 8) Precise machining
- 9) Handles matched to tip torque (Screwdrivers and T-Handles)
- 10) Worlds strongest tools - Protanium® Steel
- 11) Worlds best corrosion protection- ProGuard™ Dry Surface Technology

## Benefits

- 1) Lets tool user choose the right tool for every task
- 2) Bondhus Star tools are available in all popular standards and are specifically designed to fit all Star fasteners including TORX® brand screws.
- 3) Saves time because tool user can reach and turn screws that cannot be reached straight-in
- 4) Bondhus' extremely precise manufacturing methods create tools that work well, even in very small sizes
- 5) Screws can be turned continuously, without constantly taking the tool out of the screw, repositioning it and reinserting it, even at angles up to 20 degrees.
- 6) Bondhus ball end tips are designed to be the perfect balance between angle and strength. BallStar™ strength is maximized, while still providing a consistent full 20 degrees of working angle.
- 7) Saves time because burrs that might prevent insertion of the tool tip into the screw head are completely removed, so tip insertion is quick and easy
- 8) Saves time because precision machining means every Bondhus tool fits precisely into the screw head, minimizing breakage and stripping
- 9) T-Handle and screwdriver handles are sized to comfortably deliver an appropriate level of torque and assist in preventing damage to ball end tips.
- 10) Saves time because Bondhus' exclusive Protanium® Steel makes Bondhus tools up to 20% stronger than competitor tools and allows the tool user to deliver more torque without breaking the tool or damaging the screw head.
- 11) Saves time because the tool user does not have to work with rusty tools. ProGuard™ protection delivers up to 5 times the corrosion resistance of any other hex or Star tool finish.

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TORX® is a registered trademark of Textron, Inc.

# Star Tools

## Features

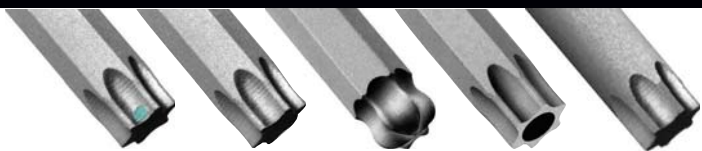
- 12) Color coded handles (Screwdrivers, T-Handles and folding tools) & cases (for hex, ball and Star sets)
- 13) Bondhex™ case (Star key sets)
  
- 14) Lifetime warranty

## Benefits

- 12) Saves time because the tool user can quickly identify inch (yellow), metric (red) and Star (green) tools
- 13) Saves time because tools are neatly organized and locked in place to prevent loss. Tools are easily removed from the case with a slight twist of the tool.
- 14) Bondhus stands behind every sale with a “No questions asked” lifetime replacement policy.

\* Bondhus, Bondhex, ProGuard, Protanium, Balldriver, BallStar, GorillaGrip, BriteGuard and GoldGuard are trademarks of Bondhus Corporation.

# Star Tools



## 1) Large selection

A wide variety of Star tip tools assures the tool user that regardless of the application, Bondhus manufactures a tool to accomplish the task:

- 5 different tip types
- Unique BallStar™ tip available
- 6 handle styles
- Sizes ranging from T5 to T60
- Optional ProHold® screw holding tips for T-Handles, screwdrivers and Star keys



BallStar™ tips are another exclusive from Bondhus. They provide the time-saving ability to insert or extract Star screws at up to a 20 degree angle. BallStar™ tips are available in screwdriver and L-wrench tool types.



10

**2) Star and Star Plus tools available** All Bondhus Star and Star Plus tools fit Torx® brand screws, but offer options and a level of quality unavailable from competitors. Bondhus wing and flag tools are available with both Star and Star Plus tips. They provide a short blade length and a handle style allowing various methods of gripping the tool. Wing and flag tools help the tool user generate higher torque levels with less hand strain.



TORX® is a registered trademark of Textron, Inc.

# Star Tools

**3) BallStar™ tips insert into screws at an angle** Bondhus ball end tools are tremendous times savers. A hex or Star tip tool can only be inserted in a screw head from a straight-on direction (0 degrees), but a Bondhus BallStar™ tip can enter from any angle up to 20 degrees, and insertion is quick and easy. The need to disassemble equipment to provide tool access to a screw head can be reduced or eliminated.



**4) Tools available for very small sizes:**

*As small as T5 (Star)*

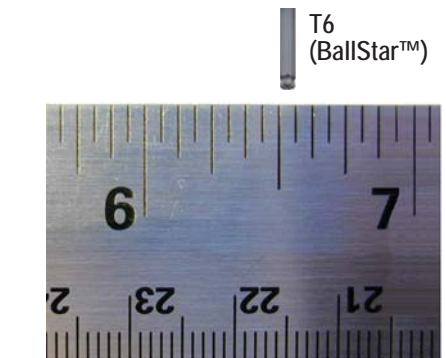
*As small as T6 (BallStar™ tip)*

Bondhus manufactures a broad selection of ball end hex and ball end Star tools for precision applications. Even in these incredibly small sizes, Bondhus tools maintain tight tolerances, highly precise machining and absolute consistency.

Bondhus precision machined tools will not strip fasteners, wear prematurely or damage delicate equipment to which repairs would be expensive and time consuming. Tool users can feel confident that Bondhus tools have the strength and precision to protect even their most delicate and expensive components.

**5) Tools work at up to a 20 degree angle**

Working with a hex or Star tool, near obstructions that block 360 degrees of handle rotation, can consume significant amounts of time. A standard hex or Star tool must be removed and reinserted with every rotation of the screw, and often, screws can only be turned a fraction of a rotation at a time.



Hex tool constantly removed and re-inserted

**Bondhus:** When using a Bondhus ball end tool, the time and effort of working in those difficult blind or hard to reach locations is greatly reduced. A Bondhus ball end can provide continuous rotation, eliminating the time-consuming need to constantly remove and reinsert the tool.



Ball end tool provides continuous rotation

Angle insertion of a screw requires a sensitive feel to know when the thread has been started straight. This is especially important when working with small screw sizes, or inserting screws into soft materials like aluminum or plastic, which are prone to cross-threading. Bondhus ball ends minimize the possibility of cross-threading by providing a full 360 degrees of smooth rotation and preserving rotational sensitivity.



**6) Funnel insertion (ball end tools)** Bondhus ball ends insert smoothly and are faster and easier to insert into a screw head than a hex or Star tip. The concept by which the ball end channels itself into a screw head is known as funnel insertion. Precise design and machining ensure that the sides of the ball funnel the tip into the screw head and seat to full depth.



## **7) Chamfered tool tips (straight hex and Star tips)**

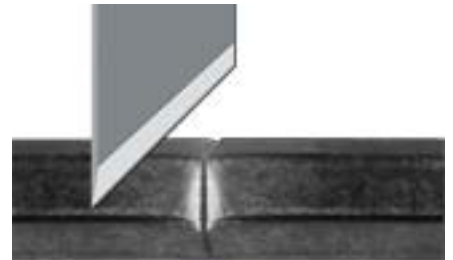
**Bondhus:** Bondhus uses a precise method of cutting, and then chamfers tips to eliminate any possibility of burrs. The chamfering makes insertion of a straight hex or Star tip into a screw head much easier. Bondhus employs several styles of chamfers, using each style where it is most effective. The type of chamfer used is not critical. The point is to ensure burrs are removed from all hex and Star keys. Bondhus hex and Star tips always insert smoothly and seat to full depth for optimal torque and longer tool life.



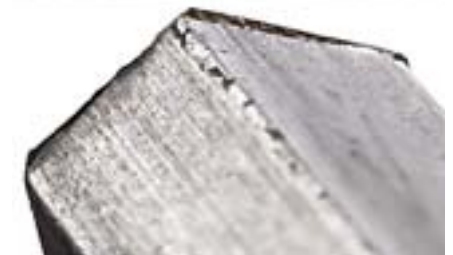
Chamfered Bondhus tip

**Competitors:** Imprecise methods of cutting produce burrs on the tips of hex and Star keys. It is common for burrs to be so large, they need to be filed away before the tool will insert into a screw head.

The clearance between a hex key and the screw walls is typically .0005" (.0127mm) or less on each side of the key, and even a very small burr can interfere with or prevent insertion. If the socket of a screw head is on the small side of its tolerance, and the hex key is on the large side of its tolerance, any amount of burr will prevent proper insertion of the tip into the screw head.



Competitor tools often feel snug in a screw head when first used, and then feel loose after only a couple of uses. The reason this happens is their tips often contain burrs. The burrs make the tool initially feel snug, but as soon as they wear off, the tips loose fit becomes obvious, and it proceeds to wear both the tool tip and the screw head quickly.



Competitor: Imprecise cutting causes burrs on tips

An imprecise cutting process can also distort the tool tip, causing it to be undersized, and to be slightly bent. Even chamfering or filing will not correct a problem of this severity.



Competitor: Tip bent by cutting process

As a last consideration, the cutting process can produce what is known as lips on the tip of a tool. Protrusions of this nature will prevent the tip from seating to the full depth in the screw head, thus increasing wear and the potential for stripping both the tool and the screw head.



Competitor: Tip with lips will not seat to full depth

## 8) Precise machining

**Bondhus:** Professional tool users recognize the Bondhus name as synonymous with quality, consistency and reliability. Bondhus is meticulous about quality and the enforcement of the tightest specifications in the hex and Star tool industry. Every tool Bondhus manufactures is subject to its own set of specifications and a company policy of no exceptions or deviations. Specifications are enforced by quality assurance testing at every stage of the manufacturing process.

Precision machining is critical for a ball end tool to function optimally. Understandably, the smaller a ball end tip is, the more complex the task of machining becomes.

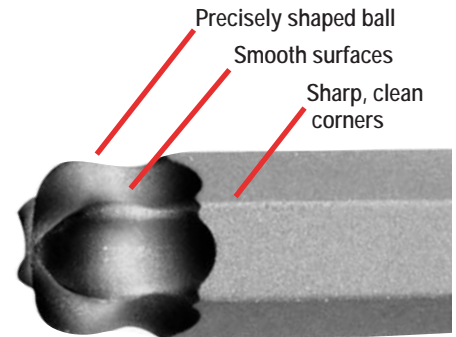
Bondhus maintains incredibly tight tolerances and close clearances between ball end tips and the screw head walls. Bondhus machining accurately maintains the precise geometric shape of the ball on all six sides. Surfaces are smooth, and corners are sharp and clean, even on a tool as small as T6.

Precise machining results in Bondhus ball end tips having more surface area contacting the screw walls than any other competitor. Bondhus ball end tools far outwear the competition, and dramatically reduce stripping. Fastener wear is also greatly reduced.

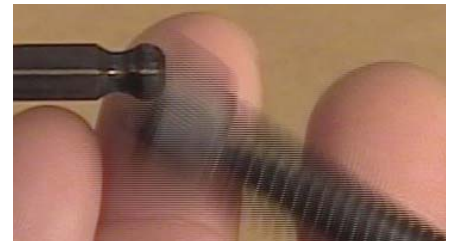
**Competitors:** Claims of quality and precision are also made by competitors who often represent their tools as “comparable”, “nearly comparable” or “good enough” when compared to Bondhus tools. Bondhus encourages head-to-head comparison and is pleased to provide all the information necessary for professional tool users to make their own informed decisions.

The ball end to the right is so poorly machined, it cannot even hold a screw in a horizontal position. Working in a blind or difficult location would be nearly impossible with this poorly machined tool tip.

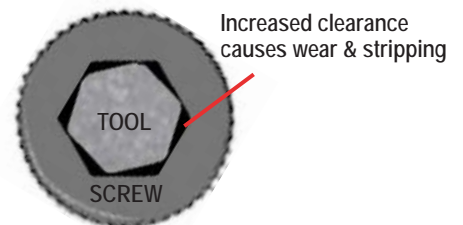
Poorly machined ball ends do not just compromise working angle. Imprecise machining can cause tips to be under-sized and not symmetrical. The clearance between the tip and screw walls increases, causing excessive wear and stripping.



Bondhus BallStar™ tip



Competitor tool



Competitor tool



## 9) Handles matched to tip torque (screwdrivers and T-Handles)

**Bondhus:** A screwdriver is capable of over-torquing its blade and can easily result in damage to the tool. Bondhus is the only manufacturer to design handles matched to the torque capacity of their blades and tips. Whether using a hex, Star or ball end tip, tool users can feel confident that applying torque will not result in breakage or damage to a Bondhus screwdriver.



A T-Handle that is too large can easily generate too much torque and risk blade or tip damage. A T-Handle that is too small requires wasted effort to generate required torque, resulting in needless user fatigue. The handles on all Bondhus T-Handles are sized to strike a balance between ease of use and protection against tool damage. Handles are large enough to easily and comfortably generate needed torque, yet small enough to help prevent accidental over-torquing that could damage the blade or tip.

Bondhus does not manufacture ball end T-Handles in sizes smaller than 5/32" and 4mm. A T-Handle could easily over-torque and break smaller size ball end tips. *Hex tips* are provided on tools of these sizes, in order to prevent tip damage.

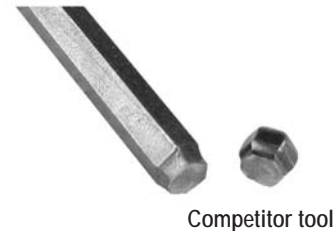
Inch	Metric
3/32"	2mm
7/64"	2.5mm
1/8"	3mm
9/64"	

T-Handles with hex tips

**Competitors:** Many screwdriver and T-Handle tools are available with handles that far exceed the torque capacity of their blades or tips. Damage and breakage, caused by over-torquing, is common to these tools.



A handle this large, is capable of generating more torque than this ball end tip can deliver. Without warning, the tip can easily be broken off.



Competitor tool

## 10) Worlds strongest tools -Protanium® Steel

### ► Protanium® High Torque Steel - a custom blended steel

Protanium® Steel is much more than “just steel” and much more than a “name”. It is a commitment to producing a level of tool performance unmatched by any competitor. Protanium® High Torque Steel is not an 8650 grade of steel, it is not a form of S-2 and it is not a chrome-vanadium or chrome-moly type of steel. Protanium® High Torque Steel is custom mixed to a formula that is the result of many years of research and continuous development efforts. Bondhus’ customized heat treating processes are the key to bringing out the superior strength properties of Protanium® High Torque Steel. Attaining results that push beyond the accepted limits of performance requires the skill and years of research and development that Bondhus alone has committed itself to.

(For more in-depth information on Protanium® Steel, please refer to Section 1 on pages 1 - 16.)

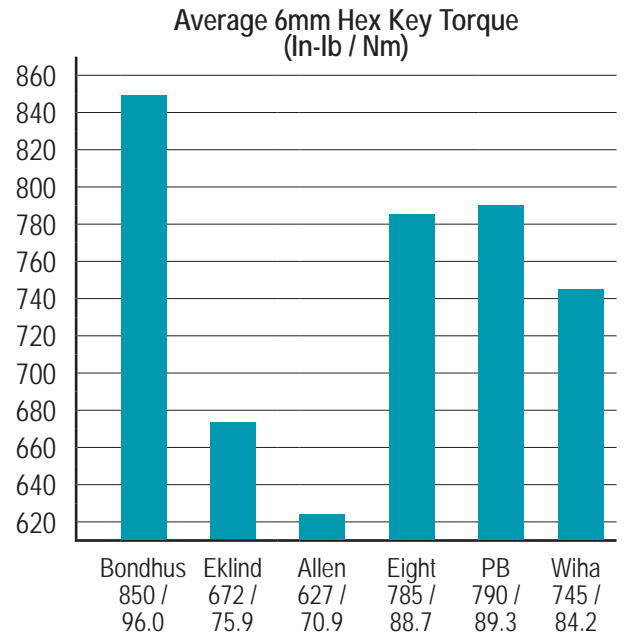
### Custom blended steel versus common grades of steel

In the broadest possible terms, only two categories of steel are used in the manufacturing of hex and Star tools; custom blended steel and standard grades of steel. A simple comparison makes it easy to see why Bondhus custom blended Protanium® Steel achieves far greater levels of performance than standard grades of steel:

Custom blended Protanium® Steel	Standard grades of steel
A custom blend specifically designed for the rigors and requirements of hex and Star tools	Standard grades of steel are a one-size-fits-all solution, designed for a range of uses, not just hex and Star tools
The elements making up the steel's composition and the process used to produce the steel are customized to the Protanium® Steel specification, enabling use of customized heat treating processes that produce tools with greater hardness and ductility	The tool manufacturer has no control over the steel's blend. Heat treating cannot be customized beyond the limitations of the standard blend
Imperfections are eliminated through the addition of specific elements and by controlling the methods by which mills produce the steel	Tool manufacturer has no control over the steel's production or imperfections that may result
Meticulous quality control, monitoring and documentation are enforced by the Protanium® Steel specification	Steel mills perform their own “standard” quality control
The drawing process is controlled to produce stock with highly precise dimensional accuracy, sharp corners and smooth clean surfaces	Tool manufacturer has little control over drawing process

Except for Bondhus, all other hex and Star tool manufacturers use various standard grades of steel in the manufacturing of their tools:

- 8650 is the most common grade in use throughout the U.S. and Asia. It does not achieve the hardness or ductility levels of Protanium® steel.
- Chrome Vanadium is comparable in performance to 8650. It is used primarily in Europe.
- Chrome Moly is similar to Chrome Vanadium, but is somewhat stronger and harder. Because it is fairly expensive, manufacturers generally only use it on their higher priced tools like ball end products, and substitute lower grades for their hex and folding tools. Europe and Japan are the primary users.
- S2 is used by only a small number of manufacturers. It is harder than 8650, but it is also less ductile, more costly, and far more prone to shattering.
- 1050 carbon steel is low-grade steel that is inferior to those listed above. It is still used by some manufacturers in Europe and Asia.



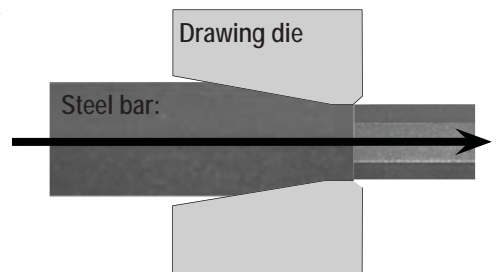
### ► *Bondhus controlled steel drawing process*

Changing the size or shape of a metal bar or rod by pulling it through a die is known as drawing. It is a critical process in the production of high quality steel, since it determines the dimensional precision and surface quality of the steel.

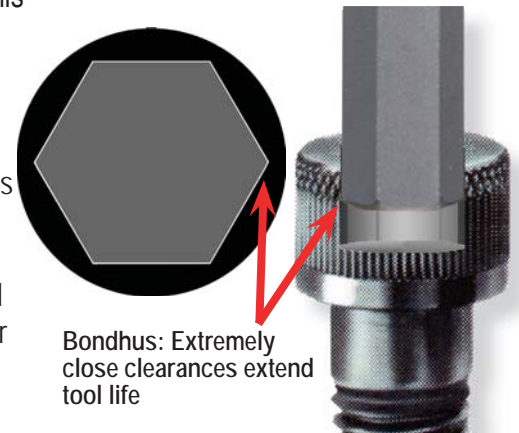
Standard grades of steel are drawn to tolerances that do not conform to the Protanium® Steel specification for precision, so Bondhus exercises full control over the drawing process. Bondhus works closely with its' steel suppliers to ensure 100% compliance with the Protanium® Steel drawing specification, and will not work with any mill unwilling to make this commitment.

#### Close clearances

Tolerances imposed by the Protanium® Steel drawing specification produce stock so precisely drawn that clearances between a Bondhus tool tip and the screw walls is typically one half thousandth of an inch or less. Clearances this close produce tool tips with greater surface area contacting the screw walls. Smaller clearances between the tool surface and the screw head mean Bondhus tools greatly reduce wear of tool tips and screw heads, and reduce or eliminate the potential of stripping.



10



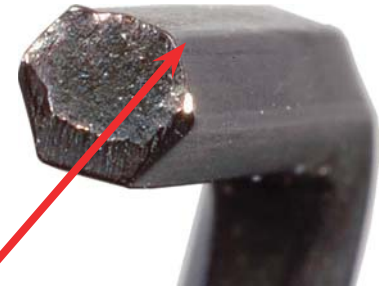
## Sharp corners

Another requirement of the Protanium® Steel drawing specification is that corners be sharp and smooth. Eliminating gaps between the tool tip corners and the screw walls means tool tip surface area increases. Tool tip and screw head wear is greatly reduced, since the primary cause of screw stripping has been eliminated.



Bondhus: Sharp, clean corners

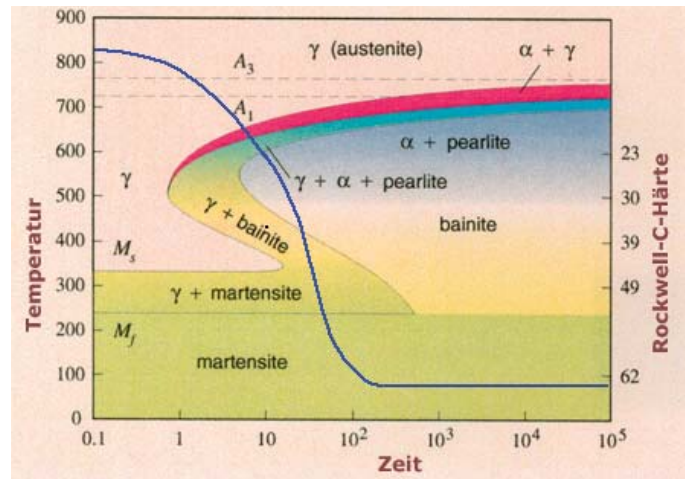
Standard grades of steel allow far more rounding of corners during the drawing process and surfaces that are not nearly as smooth, so the process of tool wear and screw stripping is accelerated. Once again, tools made with standard grades of steel perform inconsistently and unreliably.



Competitors: Rounded corners accelerate wear and stripping

## ► Customized heat treating process assures optimal combination of hardness and ductility

Heat treating is a series of processes where steel is heated to a temperature referred to as its *transformation point*, where its atomic structure actually changes. It is then cooled (quenched) in a highly controlled process where it is held at a specific *temperature* for a precise period of *time*. Complex documents known as TTT Charts (Time / Temperature / Transform) show this relationship. They assist in determining an optimal heating and quenching cycle for obtaining desired properties such as optimal microstructure, grain size, hardness and ductility.



Sample TTT chart

## Truly customized heat treating

An essential point to understand about heat treating is that the blend of the steel largely determines how and to what extent desired properties of the steel can be obtained in the heat treating process. In other words, controlling and customizing the blend of the steel is the only means by which truly customized heat treating can be accomplished. Protanium® Steel starts as a custom blended steel, and is transformed into hard, ductile tools by customized heat treat processes.

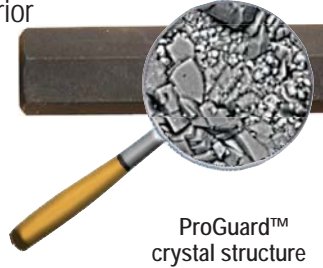
- Competitors must perform their heat treating to accommodate the limitations of the standard grades of steel they purchase. Since they have no control over the blend of the steel, their heat treating cannot achieve the levels of hardness and ductility achieved by Protanium® Steel.
- Bondhus continually improves the blend of Protanium® Steel to achieve full customization of the heat treating process. With full control of the steel's blend and its heat treating, Protanium® Steel is capable of achieving levels of hardness and ductility well beyond the limitations of the standard grades of steel used by competitors



**11) Worlds best corrosion protection - ProGuard™ Dry Surface Technology**

► **ProGuard™ surface is impermeable to moisture and contaminants**

ProGuard™ dry surface protection represents a dramatic improvement over traditional methods of protecting hex and Star tools. The ProGuard™ crystal structure provides a superior barrier against elements that cause rust and corrosion. It protects the tool for a lifetime of use and keeps tools looking attractive.



Independent lab testing has proven ProGuard™ finish is up to five times more effective than alternative finishes offered by competitors.

► **Finish is dry and clean with a final light coating of oil**

**Bondhus:** The ProGuard™ finish locks out moisture and contaminants without the ongoing requirement of an oily surface. ProGuard™ tools receive a light coat of oil prior to packaging, but do not rely on oil as their primary means of protection. Tool user's hands and work areas remain dry and clean.

**Competitors:** Tools with inadequate protection rely on the user to keep the surface sealed with oil. Tools are dirty, messy and unpleasant to work with, and corrosion protection still remains inadequate.

► **ProGuard™ finish is permanently bonded to surface of tool**

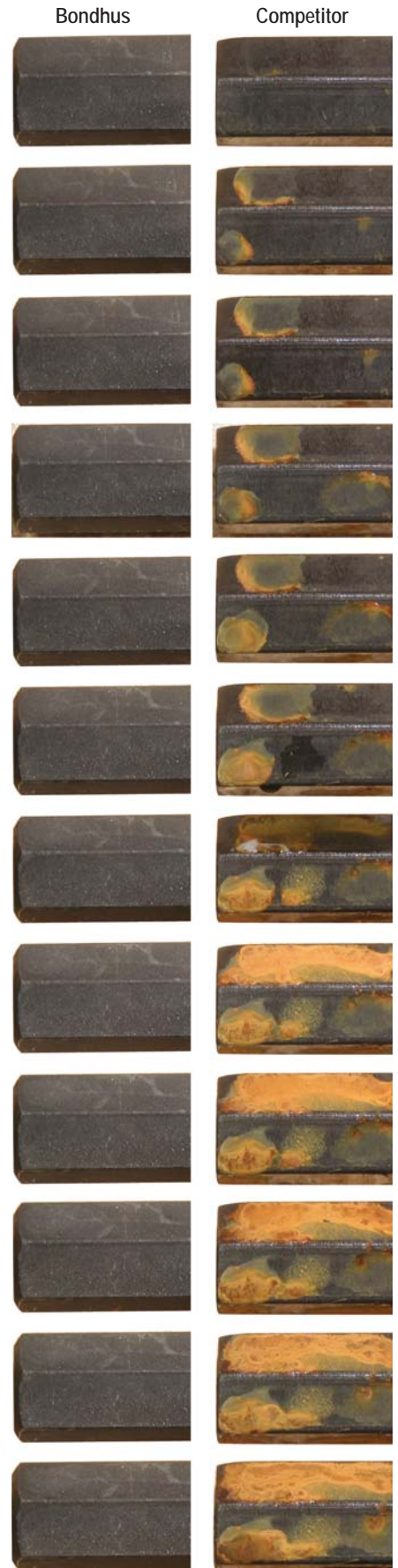
**Bondhus:** ProGuard™ protection is a proprietary finish only available on Bondhus tools. It provides a permanent finish that cannot be wiped off like a black oxide or oil finish.

Application of the ProGuard™ finish starts with a thorough caustic cleaning of the tool's surface. A small grained crystal structure is then permanently bonded to the entire surface of the tool through a ten step process. The resulting tight structure makes it very difficult for moisture and contaminants to penetrate the surface.

Smooth surfaces and sharp corners provide further protection to Bondhus tools by denying moisture and contaminants places to collect.



**12 hour time-lapse moisture test sequence**



**10**

# Star Tools

## 12) Color coded handles and cases

Color coding of Bondhus handles and cases makes inch, metric and Star tools easy to identify and distinguish from one another.

Star - green



13) **Bondhex™ case (for ball end, hex and Star key sets)** Bondhus ball end, hex and Star key sets are packed in a color coded Bondhex™ case to keep tools neat and sorted. A simple 60 degree turn locks keys in place to eliminate loose, spilled and lost keys. Tool sizes are clearly printed beneath each tool for quick size selection. A Bondhex™ case can also be used with a hex key to increase grip and comfortably generate additional torque.



14) **Lifetime warranty** Bondhus manufactures the highest quality hex and Star tools available, and every tool is backed by an unconditional lifetime warranty.

*"All Bondhus products are guaranteed for life. If you are not satisfied with a Bondhus tool - for any reason - simply return it. A replacement will be shipped right out at no cost - no hassles, no questions asked."*

A warranty is only as good as the company standing behind it. Bondhus has been the leading innovator in the hex and Star tool industry for over forty years.



## Frequently Asked Questions

### *Can Star tools be used with Torx® brand fasteners?*

Definitely. Bondhus Star and Star Plus tools are designed for a precision fit in Torx® brand screws. Bondhus Star tools also have an added advantage over competitor Star tools, because they are made from Protanium® High Torque Steel which is up to 20% stronger than competitor steels.

### *Why are there so many different styles of Star tools (wings, flags, screwdrivers, etc)?*

Bondhus believes that, just like the hex tool user, Star tool users can work more efficiently when allowed to choose the best tool type for the job. That is why Bondhus offers such a broad selection of Star tools.

### *What is the difference between Star and Star plus fasteners and tools?*

Star tools are based upon the design specification of the original Torx® brand screws, whereas Star Plus tools are based upon the more recent Torx® Plus specification. Torx® Plus was developed to be stronger.

Star tools will fit into a Star or Star Plus fastener. Star Plus tools will only fit into a Star Plus fastener.

# Bits and Blades

Bondhus manufactures and sells a wide range of ball end, hex and Star tip blades and bits, to cover almost any tool user need. Ball end tools are designed and manufactured to be strong and save time. Bondhus invented the ball end tip for use with socket screws and has achieved the ideal combination of angle and strength. Bondhus (hex) ball ends rotate smoothly in a screw head at 25 degrees. Bondhus also invented the ball end Star tool (BallStar™ tip) which allows entry, exit and work within a Star fastener at angles up to 20 degrees. Bondhus' exclusive manufacturing processes ensure the highest level of machining consistency as each tool tip is machined to incredibly tight tolerances. All Bondhus tools are manufactured with Bondhus' exclusive Protanium® Steel, which is up to 20% stronger than competitor tools and are available in many different corrosion protection finishes.

## Features

- 1) Wide variety of bits and blades
- 2) Extend tool reach with Bondhus' exclusive Hextender
- 3) Ball ends insert into screws at an angle
- 4) Tools available for very small sizes:  
As small as .028" & .71mm (hex)  
As small as .050" & 1.27mm (ball)  
As small as T5 (Star)  
As small as T6 (BallStar™ tip)
- 5) Tools work at a 25 degree angle (ball end tools)
- 6) Superior ball end strength and working angle
- 7) Funnel insertion (ball end tools)
- 8) Precise machining
- 9) Worlds strongest tools - Protanium® Steel
- 10) Worlds best corrosion protection - ProGuard™ Dry Surface Technology
- 11) Lifetime warranty
- 12) ProGuard™ (black), BriteGuard™ (chrome) and GoldGuard™ (14k gold) finishes

## Benefits

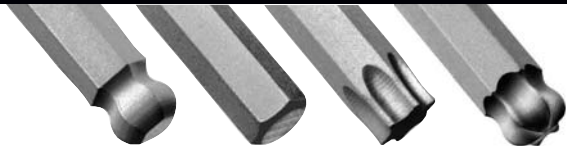
- 1) Tool users have a wide variety of tool choices to fit virtually any need.
- 2) Saves time because any like sized blades can be coupled together to create a tool length for every need
- 3) Saves time because tool user can reach and turn screws that cannot be reached straight-in
- 4) Bondhus' extremely precise manufacturing methods create tools that work very well, even in very small sizes
- 5) Screws can be turned continuously, without constantly taking the tool out of the screw, repositioning it and reinserting it, even at angles up to 25 degrees.
- 6) Bondhus ball end tips are designed to be the perfect balance between angle and strength. Ball end strength is maximized, while still providing a consistent full 25 degrees of working angle.
- 7) Saves time because Bondhus ball ends automatically funnel themselves into the screw head and seat to full depth
- 8) Saves time because precision machining means every Bondhus tool fits precisely into the screw head, minimizing breakage and stripping
- 9) Saves time because Bondhus' exclusive Protanium® Steel makes Bondhus tools up to 20% stronger than competitor tools and allows the tool user to deliver more torque without breaking the tool or damaging the screw head.
- 10) Saves time because the tool user does not have to work with rusty tools. ProGuard™ protection delivers up to 5 times the corrosion resistance of any other hex or Star tool finish.
- 11) Bondhus stands behind every sale with a "No questions asked" lifetime replacement policy
- 12) Tool users have a wide range of finish choices to fit virtually every need.



\* Bondhus, Bondhex, ProGuard, Protanium, Balldriver, BallStar, GorillaGrip, BriteGuard and GoldGuard are trademarks of Bondhus Corporation.



# Bits and Blades



## 1) Wide variety of bit and blade sizes are available

Bondhus offers hundreds of bits and blades in lengths as short as 1" (25mm) and as long as 12" (305mm).

Blade tip sizes are available as small as:

- .028" (.71mm) hex tip
- .050" (1.27mm) ball end tip
- T5 Star tip
- T6 BallStar™ tip

Time required to perform assembly and repetitive tasks can be greatly reduced. Bondhus ball end bits and blades are designed for use in a broad range of hand and power tools that accept 1/4" / 6mm hex shafts:

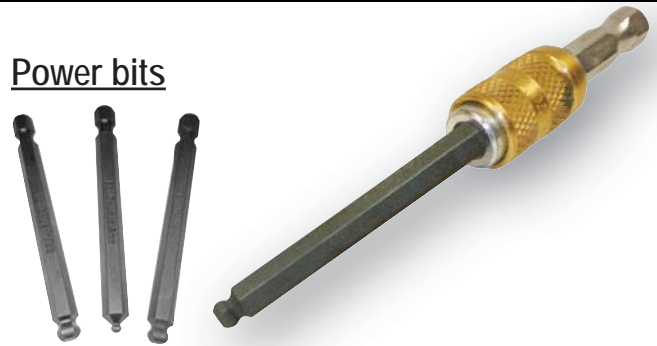
- Power drivers
- Magnetic hex adapters
- Socket wrenches
- 1/4" / 6mm chucks



## 2) Extend tool reach with Bondhus' exclusive Hextender

Sometimes, an extra long blade is a must for accomplishing a difficult task. Bondhus Hextenders allow a blade to be coupled with a hex or Star tool to provide additional length when it is needed. Even greater lengths can be accomplished by using multiple Hextender/blade combinations.

## Power bits



Ideally suited for 1/4" / 6mm ball detent hex adapters

## Insert Bits



Ideal for 1/4" / 6mm retaining ring tools

## Blades



## Hextender



# Bits and Blades

**3) Ball ends insert into screws at an angle** Bondhus ball end tools are tremendous times savers. A hex or Star tip tool can only be inserted in a screw head from a straight-on direction (0 degrees), but a Bondhus ball end tip can enter from any angle up to 25 degrees, and insertion is quick and easy. The need to disassemble equipment to provide tool access to a screw head can be reduced or eliminated.



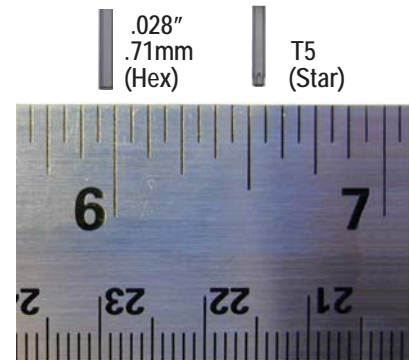
**4) Tools available for very small sizes:**

*As small as .028" & .71mm*

*As small as T5 (Star)*

Bondhus manufactures a broad selection of ball end hex and ball end Star tools for precision applications. Even in these incredibly small sizes, Bondhus tools maintain tight tolerances, highly precise machining and absolute consistency.

Bondhus precision machined tools will not strip fasteners, wear prematurely or damage delicate equipment to which repairs would be expensive and time consuming. Tool users can feel confident that Bondhus tools have the strength and precision to protect even their most delicate and expensive components.



**5) Tools work at up to a 25 degree angle (ball end tools)**

Working with a hex tool, near obstructions that block 360 degrees of handle rotation, can consume significant amounts of time. A standard hex or Star tool must be removed and reinserted with every rotation of the screw, and often, screws can only be turned a fraction of a rotation at a time.



Hex tool constantly removed and re-inserted

**Bondhus:** When using a Bondhus ball end tool, the time and effort of working in those difficult blind or hard to reach locations is greatly reduced. A Bondhus ball end can provide continuous rotation, eliminating the time-consuming need to constantly remove and reinsert the tool.



Ball end tool provides continuous rotation

Angle insertion of a screw requires a sensitive feel to know when the thread has been started straight. This is especially important when working with small screw sizes, or inserting screws into soft materials like aluminum or plastic, which are prone to cross-threading. Bondhus ball ends minimize the possibility of cross-threading by providing a full 360 degrees of smooth rotation and preserving rotational sensitivity.



# Bits and Blades

**Competitors:** An imprecisely machined ball end can deliver reduced working angle and can sacrifice smooth rotation, and in turn, not provide the sensitive feel necessary for starting a thread straight. Cross-threading can easily occur, and re-tapping a thread in a difficult location often requires time-consuming disassembly of equipment.



Competitor tool: Imprecise machining sacrifices smooth rotation

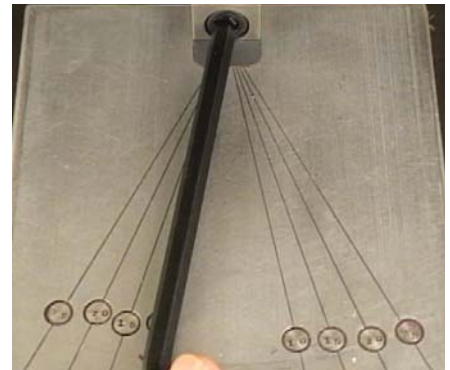
Some ball ends are not only poorly machined, they are also undersized. They can rotate smoothly only because of excessive clearance between the tip and socket walls, and give a misleading feel of precision. In just a short time, they will wear excessively, and stripping of the ball end or screw head will be the outcome.



Competitor tool: Imprecise machining causes undersized tips

## 6) Superior ball end strength and working angle

“Working angle” is the maximum angle at which a ball end can operate smoothly, while fully seated in the screw head. A quality ball end tool must provide good working angle without compromising neck strength. Bondhus ball end tools are designed to deliver a full 25 degrees of working angle, while delivering maximum neck strength.



Competitor tool: Thick neck limits working angle to only 9°

**Competitors:** Competitors manufacture ball ends from common grades of steel that lack the strength of Bondhus Protanium® Steel. To compensate for inadequate strength, some manufacturers *increase* neck size. As neck size increases, however, working angle *decreases*. Strength is improved, but working angle becomes inadequate.

To achieve working angles up to 35°, some manufacturers *reduce* neck size. Reduced neck size decreases strength, and as the recommended seating torque for the screw is approached, the risk of breakage increases. A broken tip can mean a substantial loss of time if the broken ball end jams itself in the screw head or damages the screw head.

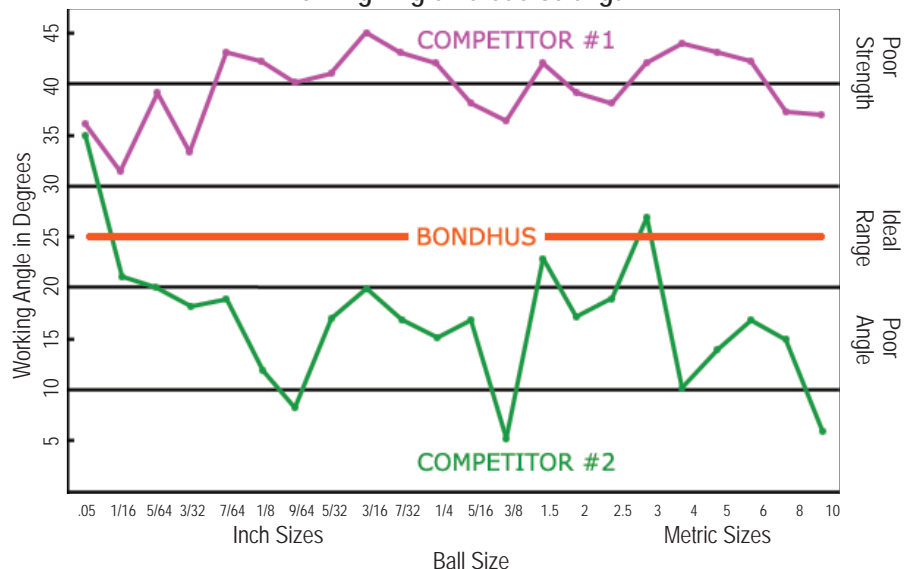


Competitor tool: Thin neck size risks breakage

**Bondhus:** Bondhus ball end tools achieve the ideal balance between working angle and strength. The strength of Protanium® Steel allows a neck size that delivers a full 25 degrees of working angle, while maintaining superior strength and wear resistance.

A blade with a hex tip begins to yield when maximum torque is reached. The tool user can easily feel that yield, and by not applying additional torque, breakage can be avoided. In contrast, a ball end tip provides no warning of impending breakage to the tool user. When over-torqued, it breaks without warning. This is one of the reasons why the strength of a Protanium® Steel ball end is such an important feature.

Ball End Comparison  
Working Angle Versus Strength



# Bits and Blades

## 7) Funnel insertion

Bondhus ball ends insert smoothly and are faster and easier to insert into a screw head than a hex tip. The concept by which the ball end channels itself into a screw head is known as funnel insertion. Precise design and machining ensure that the sides of the ball funnel the tip into the screw head and seat to full depth.



## 8) Precise machining

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Precision machining is critical for a ball end tool to function optimally. Understandably, the smaller a ball end tip is, the more complex the task of machining becomes.

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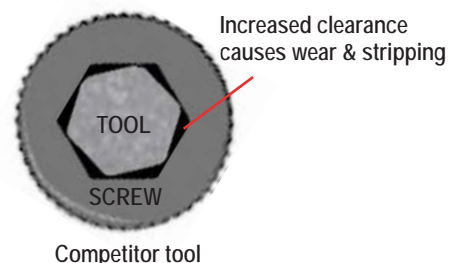
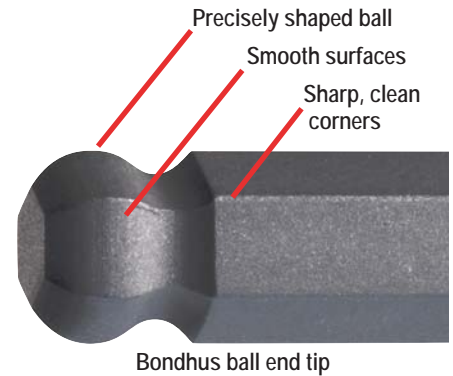
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### Competitors:

Claims of quality and precision are also made by competitors who often represent their tools as "comparable", "nearly comparable" or "good enough" when compared to Bondhus tools. Bondhus encourages head-to-head comparison and is pleased to provide all the information necessary for professional tool users to make their own informed decisions.

The ball end to the right is so poorly machined, it cannot even hold a screw in a horizontal position. Working in a blind or difficult location would be nearly impossible with this poorly machined tool tip.

Poorly machined ball ends do not just compromise working angle. Imprecise machining can cause tips to be under-sized and not symmetrical. The clearance between the tip and screw walls increases, causing excessive wear and stripping.



# Bits and Blades

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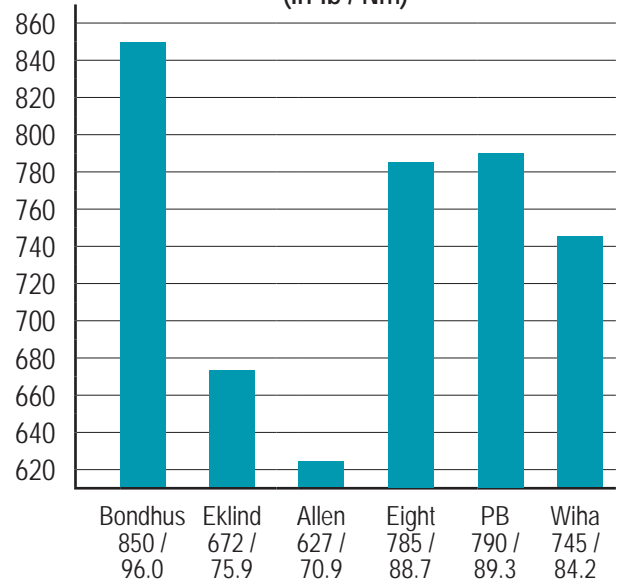
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A custom blend specifically designed for the rigors and requirements of hex and Star tools	Standard grades of steel are a one-size-fits-all solution, designed for a range of uses, not just hex and Star tools
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# Bits and Blades

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- 8650 is the most common grade in use throughout the U.S. and Asia. It does not achieve the hardness or ductility levels of Protanium® steel.
- Chrome Vanadium is comparable in performance to 8650. It is used primarily in Europe.
- Chrome Moly is similar to Chrome Vanadium, but is somewhat stronger and harder. Because it is fairly expensive, manufacturers generally only use it on their higher priced tools like ball end products, and substitute lower grades for their hex and folding tools. Europe and Japan are the primary users.
- S2 is used by only a small number of manufacturers. It is harder than 8650, but it is also less ductile, more costly, and far more prone to shattering.
- Carbon steel grades, such as 1050, are low-grade steels that are inferior to those listed above. They are still used by some manufacturers in Europe and Asia.

Average 6mm Hex Key Torque  
(In-lb / Nm)



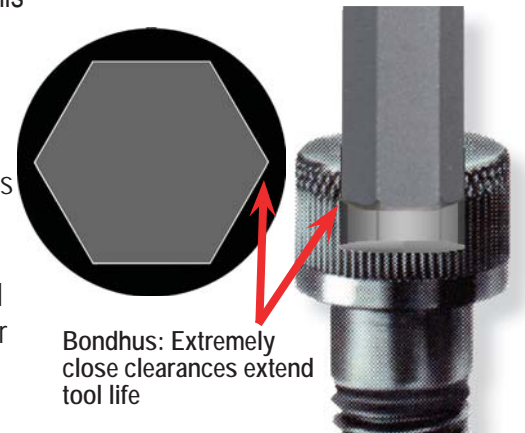
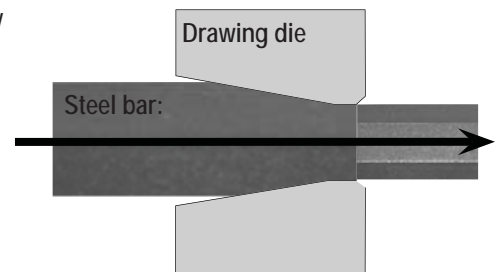
## ► *Bondhus controlled steel drawing process*

Changing the size or shape of a metal bar or rod by pulling it through a die is known as drawing. It is a critical process in the production of high quality steel, since it determines the dimensional precision and surface quality of the steel.

Standard grades of steel are drawn to tolerances that do not conform to the Protanium® Steel specification for precision, so Bondhus exercises full control over the drawing process. Bondhus works closely with its' steel suppliers to ensure 100% compliance with the Protanium® Steel drawing specification, and will not work with any mill unwilling to make this commitment.

### Close clearances

Tolerances imposed by the Protanium® Steel drawing specification produce stock so precisely drawn that clearances between a Bondhus tool tip and the screw walls is typically one half thousandth of an inch or less. Clearances this close produce tool tips with greater surface area contacting the screw walls. Smaller clearances between the tool surface and the screw head mean Bondhus tools greatly reduce wear of tool tips and screw heads, and reduce or eliminate the potential of stripping.



# Bits and Blades

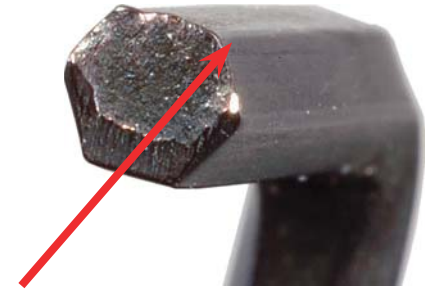
## Sharp corners

Another requirement of the Protanium® Steel drawing specification is that corners be sharp and smooth. Eliminating gaps between the tool tip corners and the screw walls means tool tip surface area increases. Tool tip and screw head wear is greatly reduced, since the primary cause of screw stripping has been eliminated.

Standard grades of steel allow far more rounding of corners during the drawing process and surfaces that are not nearly as smooth, so the process of tool wear and screw stripping is accelerated. Once again, tools made with standard grades of steel perform inconsistently and unreliably.



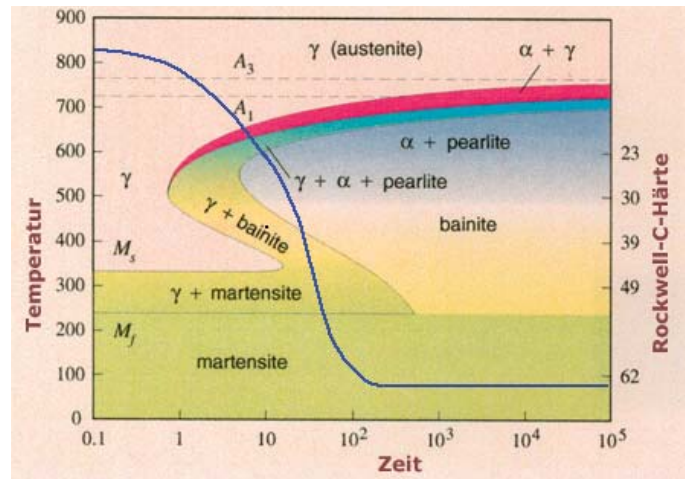
Bondhus: Sharp, clean corners



Competitors: Rounded corners accelerate wear and stripping

## ► Customized heat treating process assures optimal combination of hardness and ductility

Heat treating is a series of processes where steel is heated to a temperature referred to as its *transformation point*, where its atomic structure actually changes. It is then cooled (quenched) in a highly controlled process where it is held at a specific *temperature* for a precise period of *time*. Complex documents known as TTT Charts (Time / Temperature / Transform) show this relationship. They assist in determining an optimal heating and quenching cycle for obtaining desired properties such as optimal microstructure, grain size, hardness and ductility.



Sample TTT chart

## Truly customized heat treating

An essential point to understand about heat treating is that the blend of the steel largely determines how and to what extent desired properties of the steel can be obtained in the heat treating process. In other words, controlling and customizing the blend of the steel is the only means by which truly customized heat treating can be accomplished. Protanium® Steel starts as a custom blended steel, and is transformed into hard, ductile tools by customized heat treat processes.

- Competitors must perform their heat treating to accommodate the limitations of the standard grades of steel they purchase. Since they have no control over the blend of the steel, their heat treating cannot achieve the levels of hardness and ductility achieved by Protanium® Steel.
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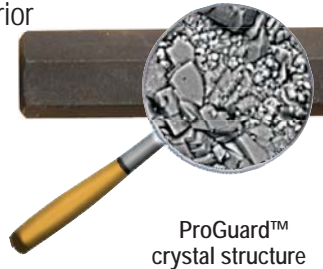


# Bits and Blades

## 10) Worlds best corrosion protection - ProGuard™ Dry Surface Technology

### ► ProGuard™ surface is impermeable to moisture and contaminants

ProGuard™ dry surface protection represents a dramatic improvement over traditional methods of protecting hex and Star tools. The ProGuard™ crystal structure provides a superior barrier against elements that cause rust and corrosion. It protects the tool for a lifetime of use and keeps tools looking attractive.



Independent lab testing has proven ProGuard™ finish is up to five times more effective than alternative finishes offered by competitors.

### ► Finish is dry and clean with a final light coating of oil

**Bondhus:** The ProGuard™ finish locks out moisture and contaminants without the ongoing requirement of an oily surface. ProGuard™ tools receive a light coat of oil prior to packaging, but do not rely on oil as their primary means of protection. Tool user's hands and work areas remain dry and clean.

**Competitors:** Tools with inadequate protection rely on the user to keep the surface sealed with oil. Tools are dirty, messy and unpleasant to work with, and corrosion protection still remains inadequate.

### ► ProGuard™ finish is permanently bonded to surface of tool

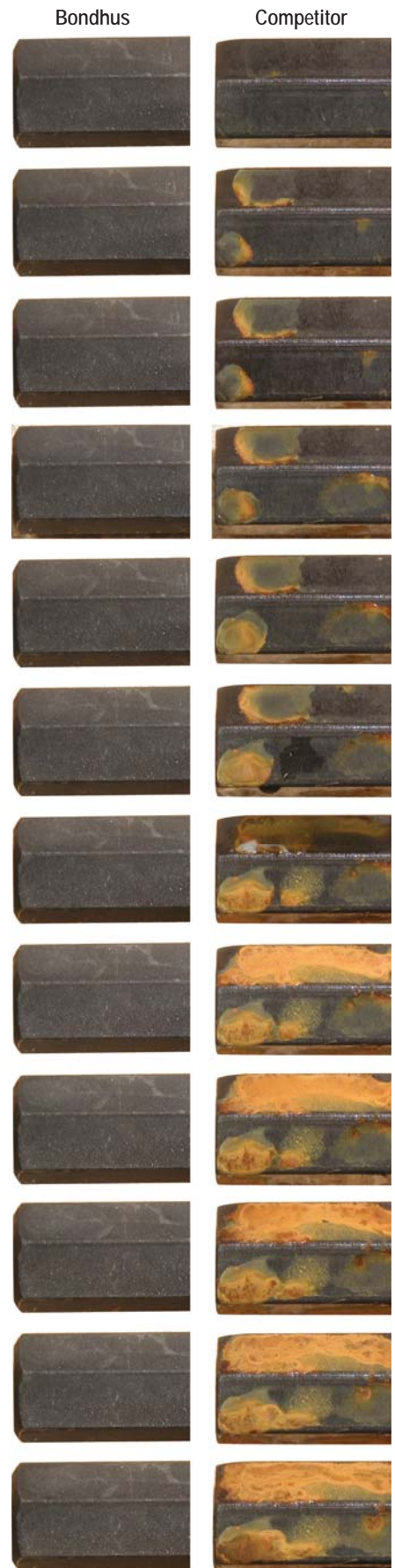
**Bondhus:** ProGuard™ protection is a proprietary finish only available on Bondhus tools. It provides a permanent finish that cannot be wiped off like a black oxide or oil finish.

Application of the ProGuard™ finish starts with a thorough caustic cleaning of the tool's surface. A small grained crystal structure is then permanently bonded to the entire surface of the tool through a ten step process. The resulting tight structure makes it very difficult for moisture and contaminants to penetrate the surface.

Smooth surfaces and sharp corners provide further protection to Bondhus tools by denying moisture and contaminants places to collect.



## 12 hour time-lapse moisture test sequence





# Bits and Blades

## 11) Lifetime warranty

Bondhus manufactures the highest quality hex and Star tools available, and every tool is backed by an unconditional lifetime warranty.

*"All Bondhus products are guaranteed for life. If you are not satisfied with a Bondhus tool - for any reason - simply return it. A replacement will be shipped right out at no cost - no hassles, no questions asked."*

A warranty is only as good as the company standing behind it. Bondhus has been the leading innovator in the hex and Star tool industry for over forty years.



## 12) ProGuard™ (black), BriteGuard™ (chrome) and GoldGuard™ (14k gold) finishes

Bondhus offers tool users the choice of three different types of corrosion protection. ProGuard™ protection is the most effective solution available, and is available on all Bondhus tools. For tool users who prefer a plated finish, BriteGuard™ protection provides a traditional chrome finish and GoldGuard™ protection provides a genuine 14 karat gold finish.



# Bits and Blades

## Frequently Asked Questions

### *Can Bondhus bits and blades be used with impact tools?*

YES. Bondhus insert bits, power bits and blades are all designed for use in a wide range of handheld and power tools.

### *What is the difference between a bit and a blade?*

Bondhus "insert bits" are 1" (25mm) in length and designed for tools with 1/4" retaining ring or magnetic hex adapters. Power bits are 3" (76mm) in length and designed for tools with 1/4" ball detent hex adapters. Bondhus blades are available in graduated lengths ranging from 3.4" (86mm) to 14.5" (368mm). They are designed for use in socket tools, chucks and similar tools accepting hex type shanks.

# ProHold® Socket Bits

Bondhus ProHold® socket bits are designed to be strong and to save time and money. Prior to the development of Bondhus' exclusive ProHold® socket bits, tool users had to buy expensive socket and bit combinations. Our unique holding buttons "snap" the bit securely into any six point socket, allowing the tool user to buy just the bit, rather than an expensive socket and bit assembly. Bondhus ProHold® socket bits do not require use of roll pins or set screws to hold the bit in the socket.

Bondhus' exclusive manufacturing processes ensure the highest level of machining consistency as each ProHold® socket bit is machined to incredibly tight tolerances.

All Bondhus ProHold® socket bits are manufactured from Bondhus' exclusive Protanium® Steel, which is up to 20% stronger than competitor tools, and finished with its' proprietary ProGuard™ corrosion resistant finish. ProHold® socket bits are protected by US and foreign patents, ensuring ProHold® socket bits are only available from Bondhus.



## Features

- 1) Holding buttons on socket end of bit
- 2) Quick and economical bit replacement
- 3) Available in a wide size range: 5/32 - 3/4", 3 - 19mm, T7 - T60
- 4) Superior ball end strength and working angle
- 5) Funnel insertion (ball end tools)
- 6) Precise machining
- 7) Consistent 25° working angle on ball end tools
- 8) Worlds strongest bits - Protanium® Steel
- 9) Worlds best corrosion protection - ProGuard™ Dry Surface Technology
- 10) Lifetime warranty

## Benefits

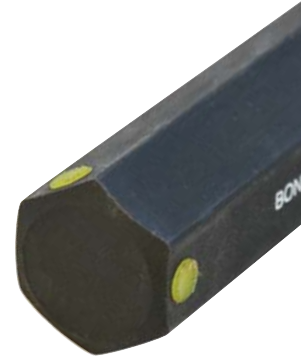
- 1) Saves tool user time and money. Two ProHold® buttons provide plenty of holding power. Bits can be quickly inserted or removed from any six point socket, with no need for special tools.
- 2) Saves time because new ProHold® bits can quickly be inserted in the socket using no special tools. Saves money because only a new bit needs to be purchased when the old one wears out. Sockets can always be reused.
- 3) Saves time because there is a Bondhus ProHold® socket bit designed for every hex and Star screw head.
- 4) Bondhus ball end tips are designed to be the perfect balance between angle and strength. Ball end strength is maximized, while still providing a consistent full 25 degrees of working angle.
- 5) Saves time because Bondhus ball ends automatically funnel themselves into the screw head and seat to full depth
- 6) Saves time because precision machining means every Bondhus tool fits precisely into the screw head, minimizing breakage and stripping
- 7) Saves time because tool users can absolutely count on every Bondhus ball end tool to provide a full 25° of working angle.
- 8) Saves time because Bondhus' exclusive Protanium® Steel makes Bondhus tools up to 20% stronger than competitor tools and allows the tool user to deliver more torque without breaking the tool or damaging the screw head.
- 9) Saves time because the tool user does not have to work with rusty tools. ProGuard™ protection delivers up to 5 times the corrosion resistance of any other hex or Star tool finish.
- 10) Bondhus stands behind every sale with a "No questions asked" lifetime replacement policy

# ProHold® Socket Bits



## 1) Holding buttons on socket end of bit

Any socket bit needs to be held securely in its' driving socket. Bondhus uses two patented ProHold® buttons to retain the bit in the socket. The buttons are designed to retain the bit in any six point socket. The ProHold® buttons are flexible and very tough.



## 2) Quick and economical bit replacement

Bondhus ProHold® socket bits are easy to remove from the socket. A sharp pull on the bit, or a tap with a punch through the center of the socket, is all that is required to separate the bit from the socket.

ProHold® bits put an end to the expensive and wasteful necessity of throwing away perfectly serviceable sockets just to replace a bit.

### Competitor socket bits:

If a competitor socket bit needs replacing, the tool user must either replace the entire socket and bit assembly or somehow locate a replacement bit that exactly matches the method of retention, i.e. set screw, roll pin, etc. It is usually impossible to find the exact replacement bit.



Competitor tools

## 3) Available in a wide size range:

*5/32 - 3/4", 3 - 19mm, T7 - T60*

ProHold® Socket Bits are available in a full range of sizes with either hex or Star tips. They can be purchased as sets or singles, and with or without sockets.

# ProHold® Socket Bits

4) *ProHold® Ball ends insert into screws at an angle* Bondhus ball end tools are tremendous times savers. A hex or Star tip tool can only be inserted in a screw head from a straight-on direction (0 degrees), but a Bondhus ProHold® ball end tip can enter from any angle up to 25 degrees, and insertion is quick and easy. The need to disassemble equipment to provide tool access to a screw head can be reduced or eliminated.



6) *Tools work at up to a 25 degree angle (ball end tools)*

Working with a hex tool, near obstructions that block 360 degrees of handle rotation, can consume significant amounts of time. A standard hex or Star tool must be removed and reinserted with every rotation of the screw, and often, screws can only be turned a fraction of a rotation at a time.



**Bondhus:** When using a Bondhus ball end tool, the time and effort of working in those difficult blind or hard to reach locations is greatly reduced. A Bondhus ball end can provide continuous rotation, eliminating the time-consuming need to constantly remove and reinsert the tool.



Hex tool constantly removed and re-inserted

Angle insertion of a screw requires a sensitive feel to know when the thread has been started straight. This is especially important when working with small screw sizes, or inserting screws into soft materials like aluminum or plastic, which are prone to cross-threading. Bondhus ball ends minimize the possibility of cross-threading by providing a full 360 degrees of smooth rotation and preserving rotational sensitivity.



Ball end tool provides continuous rotation

# ProHold® Socket Bits

**Competitors:** An imprecisely machined ball end can deliver reduced working angle and can sacrifice smooth rotation, and in turn, not provide the sensitive feel necessary for starting a thread straight. Cross-threading can easily occur, and re-tapping a thread in a difficult location often requires time-consuming disassembly of equipment.



Competitor tool: Imprecise machining sacrifices smooth rotation

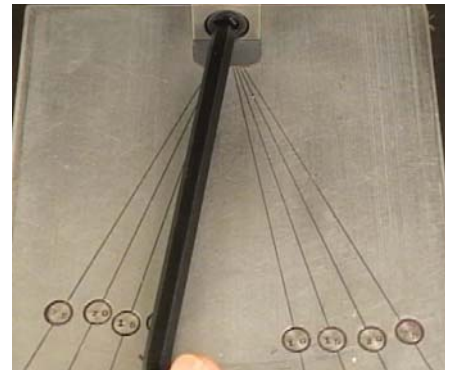
Some ball ends are not only poorly machined, they are also undersized. They can rotate smoothly only because of excessive clearance between the tip and socket walls, and give a misleading feel of precision. In just a short time, they will wear excessively, and stripping of the ball end or screw head will be the outcome.



Competitor tool: Imprecise machining causes undersized tips

## 7) Superior ball end strength and working angle

"Working angle" is the maximum angle at which a ball end can operate smoothly, while fully seated in the screw head. A quality ball end tool must provide good working angle without compromising neck strength. Bondhus ball end tools are designed to deliver a full 25 degrees of working angle, while delivering maximum neck strength.



Competitor tool: Thick neck limits working angle to only 9°

**Competitors:** Competitors manufacture ball ends from common grades of steel that lack the strength of Bondhus Protanium® Steel. To compensate for inadequate strength, some manufacturers *increase* neck size. As neck size increases, however, working angle *decreases*. Strength is improved, but working angle becomes inadequate.

To achieve working angles up to 35°, some manufacturers *reduce* neck size. Reduced neck size decreases strength, and as the recommended seating torque for the screw is approached, the risk of breakage increases. A broken tip can mean a substantial loss of time if the broken ball end jams itself in the screw head or damages the screw head.

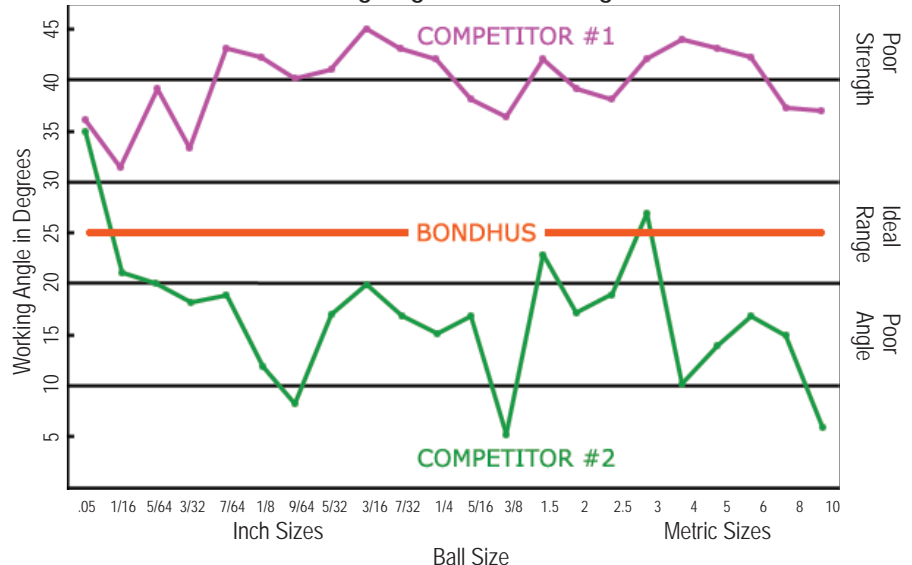


Competitor tool: Thin neck size risks breakage

**Bondhus:** Bondhus ball end tools achieve the ideal balance between working angle and strength. The strength of Protanium® Steel allows a neck size that delivers a full 25 degrees of working angle, while maintaining superior strength and wear resistance.

A blade with a hex tip begins to yield when maximum torque is reached. The tool user can easily feel that yield, and by not applying additional torque, breakage can be avoided. In contrast, a ball end tip provides no warning of impending breakage to the tool user. When over-torqued, it breaks without warning. This is one of the reasons why the strength of a Protanium® Steel ball end is such an important feature.

Ball End Comparison  
Working Angle Versus Strength



# ProHold® Socket Bits

## 8) Funnel insertion

Bondhus ball ends insert smoothly and are faster and easier to insert into a screw head than a hex tip. The concept by which the ball end channels itself into a screw head is known as funnel insertion. Precise design and machining ensure that the sides of the ball funnel the tip into the screw head and seat to full depth.



## 9) Precise machining

**Bondhus:** Professional tool users recognize the Bondhus name as synonymous with quality, consistency and reliability. Bondhus is meticulous about quality and the enforcement of the tightest specifications in the hex and Star tool industry. Every tool Bondhus manufactures is subject to its own set of specifications and a company policy of no exceptions or deviations. Specifications are enforced by quality assurance testing at every stage of the manufacturing process.

Precision machining is critical for a ball end tool to function optimally. Understandably, the smaller a ball end tip is, the more complex the task of machining becomes.

Bondhus maintains incredibly tight tolerances and close clearances between ball end tips and the screw head walls. Bondhus machining accurately maintains the precise geometric shape of the ball on all six sides. Surfaces are smooth, and corners are sharp and clean, even on a tool as small as .050" (1.27mm).

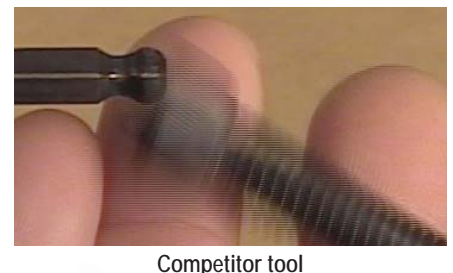
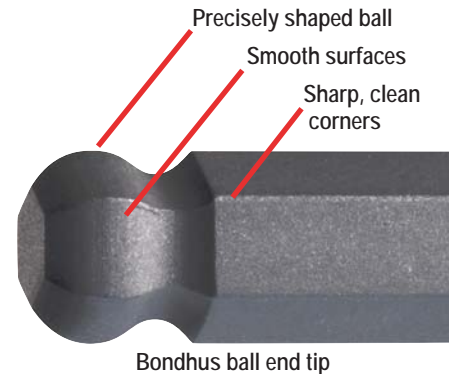
Precise machining results in Bondhus ball end tips having more surface area contacting the screw walls than any other competitor. Bondhus ball end tools far outwear the competition, and dramatically reduce stripping. Fastener wear is also greatly reduced.

### Competitors:

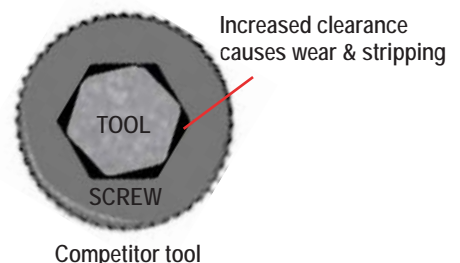
Claims of quality and precision are also made by competitors who often represent their tools as "comparable", "nearly comparable" or "good enough" when compared to Bondhus tools. Bondhus encourages head-to-head comparison and is pleased to provide all the information necessary for professional tool users to make their own informed decisions.

The ball end to the right is so poorly machined, it cannot even hold a screw in a horizontal position. Working in a blind or difficult location would be nearly impossible with this poorly machined tool tip.

Poorly machined ball ends do not just compromise working angle. Imprecise machining can cause tips to be under-sized and not symmetrical. The clearance between the tip and screw walls increases, causing excessive wear and stripping.



Competitor tool



Competitor tool

# ProHold® Socket Bits

## 10) Worlds strongest tools -Protanium® Steel

### ► Protanium® High Torque Steel - a custom blended steel

Protanium® Steel is much more than “just steel” and much more than a “name”. It is a commitment to producing a level of tool performance unmatched by any competitor. Protanium® High Torque Steel is not an 8650 grade of steel, it is not a form of S-2 and it is not a chrome-vanadium or chrome-moly type of steel. Protanium® High Torque Steel is custom mixed to a formula that is the result of many years of research and continuous development efforts. Bondhus’ customized heat treating processes are the key to bringing out the superior strength properties of Protanium® High Torque Steel. Attaining results that push beyond the accepted limits of performance requires the skill and years of research and development that Bondhus alone has committed itself to.

(For more in-depth information on Protanium® Steel, please refer to Section 1 on pages 1 - 16.)

### Custom blended steel versus common grades of steel

In the broadest possible terms, only two categories of steel are used in the manufacturing of hex and Star tools; custom blended steel and standard grades of steel. A simple comparison makes it easy to see why Bondhus custom blended Protanium® Steel achieves far greater levels of performance than standard grades of steel:

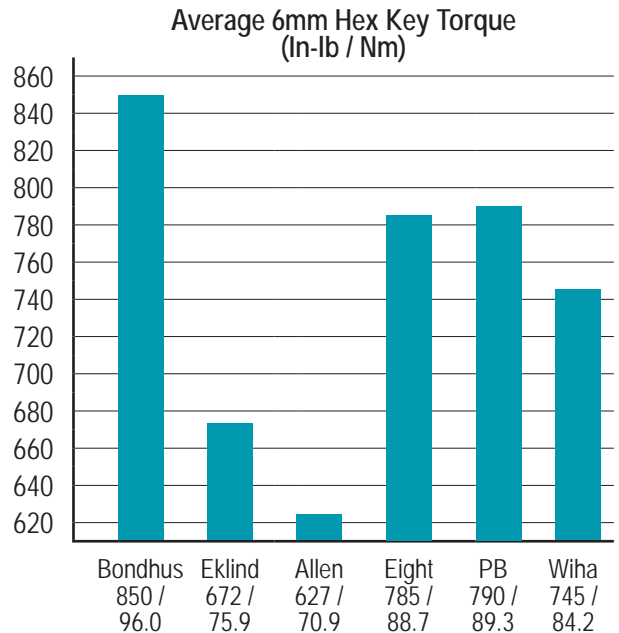
Custom blended Protanium® Steel	Standard grades of steel
A custom blend specifically designed for the rigors and requirements of hex and Star tools	Standard grades of steel are a one-size-fits-all solution, designed for a range of uses, not just hex and Star tools
The elements making up the steel's composition and the process used to produce the steel are customized to the Protanium® Steel specification, enabling use of customized heat treating processes that produce tools with greater hardness and ductility	The tool manufacturer has no control over the steel's blend. Heat treating cannot be customized beyond the limitations of the standard blend
Imperfections are eliminated through the addition of specific elements and by controlling the methods by which mills produce the steel	Tool manufacturer has no control over the steel's production or imperfections that may result
Meticulous quality control, monitoring and documentation are enforced by the Protanium® Steel specification	Steel mills perform their own “standard” quality control
The drawing process is controlled to produce stock with highly precise dimensional accuracy, sharp corners and smooth clean surfaces	Tool manufacturer has little control over drawing process



# ProHold® Socket Bits

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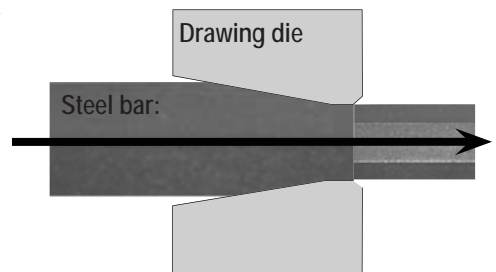
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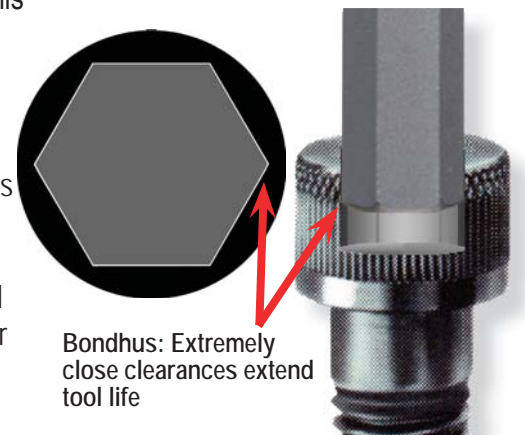
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# ProHold® Socket Bits

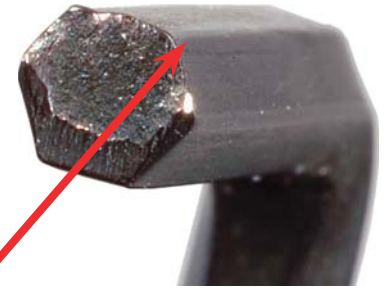
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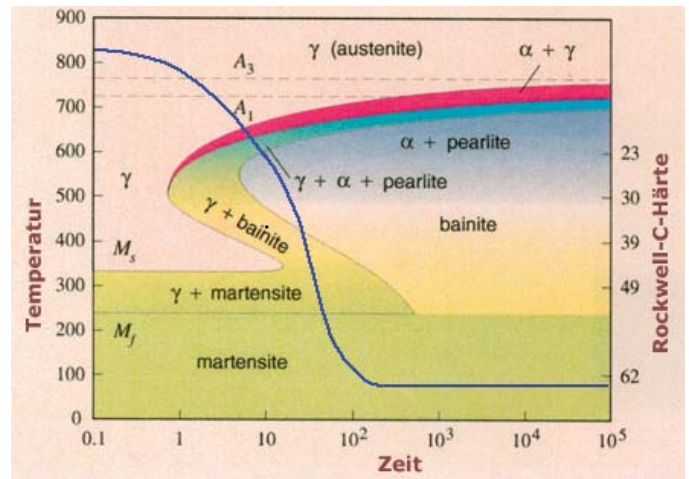
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Sample TTT chart

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- Competitors must perform their heat treating to accommodate the limitations of the standard grades of steel they purchase. Since they have no control over the blend of the steel, their heat treating cannot achieve the levels of hardness and ductility achieved by Protanium® Steel.
- Bondhus continually improves the blend of Protanium® Steel to achieve full customization of the heat treating process. With full control of the steel's blend and its heat treating, Protanium® Steel is capable of achieving levels of hardness and ductility well beyond the limitations of the standard grades of steel used by competitors

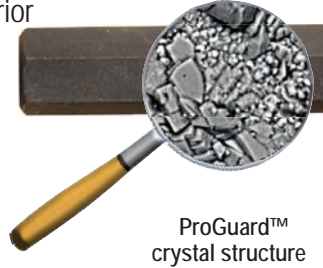


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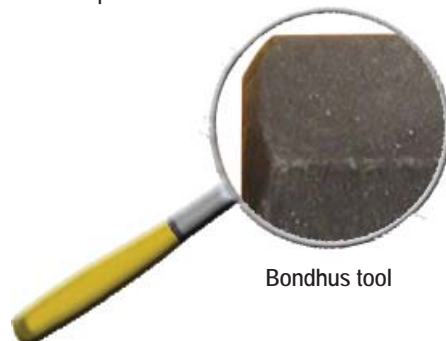
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### ► ProGuard™ finish is permanently bonded to surface of tool

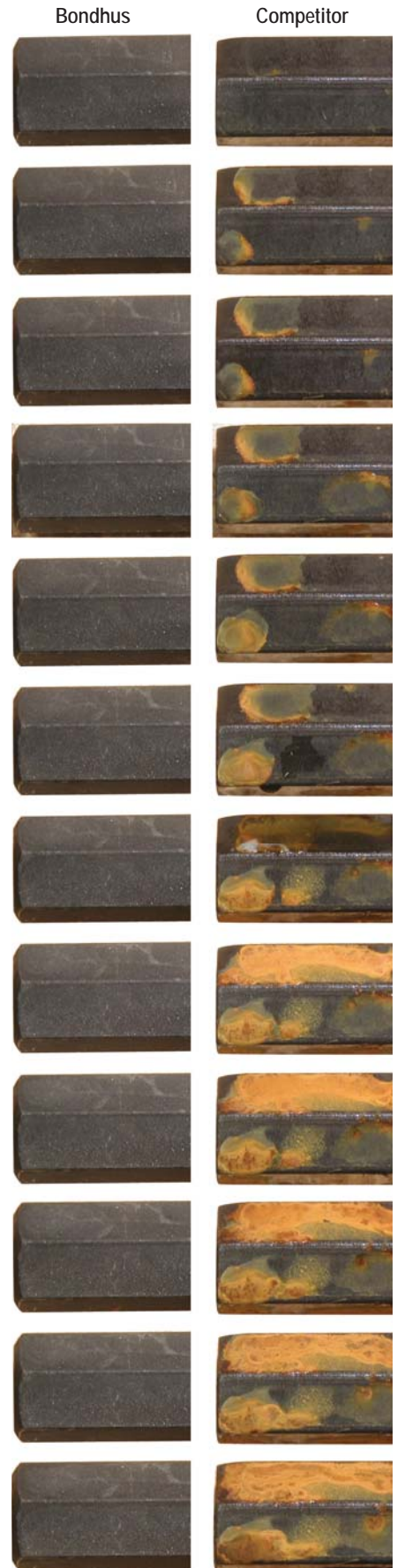
**Bondhus:** ProGuard™ protection is a proprietary finish only available on Bondhus tools. It provides a permanent finish that cannot be wiped off like a black oxide or oil finish.

Application of the ProGuard™ finish starts with a thorough caustic cleaning of the tool's surface. A small grained crystal structure is then permanently bonded to the entire surface of the tool through a ten step process. The resulting tight structure makes it very difficult for moisture and contaminants to penetrate the surface.

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## 12 hour time-lapse moisture test sequence



# ProHold® Socket Bits

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# ProHold® Socket Bits

## Frequently Asked Questions

### *Can I use ProHold® Socket Bits in any socket?*

ProHold® Socket Bits are designed to work in any six point socket. This eliminates the need to dedicate a separate set of sockets for occasional socket bit use.

### *Can I use Bondhus ProHold® Bits with my impact tool?*

A Bondhus Socket bit can be used with impact tools. We recommend the use of an impact rated socket for this application.

### *Are ball end tips as strong as standard hex tips?*

Every ball end tool has a “neck” which is smaller in diameter than the tip size, so it cannot have quite as much strength as a straight hex tip. However, all Bondhus ball ends have the advantage of being manufactured from Protanium® Steel, which is up to 20% stronger than the standard grades of steel used by competitors.

### *Why do Bondhus ball ends have a 25 degree working angle instead of the lesser or greater working angle of some competitors?*

Through extensive testing, Bondhus has determined that 25 degrees provides the optimal combination of strength and working angle. Competitor tools with greater than 25 degrees of working angle sacrifice strength and are too weak to perform many common applications without breakage. Competitor tools with less than 25 degrees of working angle are somewhat stronger, but sacrifice too much working angle, and the whole purpose of a ball end tool (saving time) is defeated.

### *Will the Bondhus ProHold® Insert Bits loosen over time?*

Bondhus ProHold® Insert Bits have two buttons to assure strong retention and longevity. They also have a lifetime warranty from Bondhus.

### *Do I need special tools to insert or remove the bit from a socket?*

No. Initially you may find it a little hard to insert the ProHold® Bit and/or extract it since the bits are designed for a very snug fit in the socket. You may want to use a punch or screwdriver to push the bit out of the socket.

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# Technical Library

## Hex and Star Fastener Information

The fasteners used with hex tools are available in an incredibly wide range of sizes and strengths, and with features unique to the various types. Hex fasteners are available for nearly any assembly project where critical factors will not permit the use of lower quality alternative fasteners.

### Common screw types



#### Socket Head Cap Screw

Uses: Applications where maximum strength is required. Used as protruding or counter bored.

#### Variations for special use:

- High temperature
- Corrosive environments
- Maximum tensile strength critical
- Cleanliness required



#### Low Head Socket Head Cap Screw

Uses: Applications where parts are not thick enough to be counterbored or clearance is too limited to use full height cap screw.



#### Shoulder Screw

Uses: Applications where the shoulder screw can actually replace more expensive parts such as trunnion mountings, shafts, or guides.



#### Button Head Screw

Uses: Applications with low limited clearance: parts are not thick enough to be counterbored; loading capacity is not critical.



#### Flat Head Screw

Uses: Applications where head needs to be flush with surface.



#### Socket Set Screw

Uses: Fastening parts on a shaft – pulleys, gears, collars, etc.

#### Variations:

- High temp applications
- Corrosive environments

#### Points available for:

- Shafts of varying hardness
- Parts needing frequent adjustment or removal
- Applications where positive locking critical.

**Strength and savings:** An assembly done with a cap screw has over 50% more tensile strength, 100% better yield strength, and over 30% more shear strength. An assembly with three socket head cap screws has more strength than one with five equivalent hex head screws. Using fewer screws means labor savings associated with drilling fewer holes and installing fewer screws.



**Clearance:** Socket head cap screws have no side clearance restrictions associated with the sockets and wrenches used with hex head screws. As a result, they can be placed closer together, and used in applications where associated side clearance would make hex head screws impractical.



When overhead clearance is an issue, or a flush profile is necessary, the low head and flat head versions are a good solution.



# Technical Library

## Torque Calculation

**Torque is defined as:** The measure of the force applied to produce rotational motion (usually measured in foot-pounds). Torque is determined by multiplying the applied force by the distance from the pivot point to the point where the force is applied.

- In the English system, torque is measured in "foot-pounds" or "inch-pounds".
- In the Metric system, torque is measured in "Newton-meters".
- 8.851 inch-pounds = 1 Newton-meter
- 1 foot-pound = 12 inch-pounds
- 16 ounce-inches = 1 inch-pound
- 1 Newton = 1 kilogram-meter per second squared
- Torque = Force x Moment Arm

### Conversion Formulas






Multiply	By	To obtain
foot-pounds	12.0000	inch-pounds
Newton-meters	8.8508	inch-pounds
kilogram-meters	86.7964	inch-pounds
inch-pounds	0.0833	foot-pounds
Newton-meters	0.7376	foot-pounds
kilogram-meters	7.2330	foot-pounds
inch-pounds	0.1130	Newton-meters
foot-pounds	1.3558	Newton-meters
kilogram-meters	9.8067	Newton-meters
foot-pounds	0.1383	kilogram-meters
inch-pounds	0.0115	kilogram-meters
Newton-meters	0.1020	kilogram-meters





# Technical Library

## Torque and Screw Interchangeability

Hex Size  Inch	Torque Capacity**				Screw Interchangeability				
	Bondhus® Straight Hex		Bondhus® Ball End Tip						
	in-lb	Nm	in-lb	Nm					
.050	7.9	0.9	3	0.3	0	1, 2	1, 2	3, 4	---
1/16	15.9	1.8	7	0.8	1	3, 4	3, 4	5, 6	---
5/64	34	3.8	13	1.5	2, 3	5, 6	5, 6	8	---
3/32	51	5.8	24	2.8	4, 5	8	8	10	---
7/64	84	9.5	39	4.4	6	10	---	---	---
1/8	129	14.6	57	6.4	---	---	10	1/4	1/4
9/64	185	20.9	86	9.7	8	1/4	---	---	---
5/32	265	29.9	127	14.4	10	5/16	1/4	5/16	5/16
3/16	431	48.7	189	21.4	1/4	3/8	5/16	3/8	3/8
7/32	673	76.0	318	35.9	---	7/16	3/8	7/16	---
1/4	950	107.4	482	54.4	5/16	1/2	---	1/2	1/2
5/16	2022	228.5	888	100.3	3/8	5/8	1/2	5/8	5/8
3/8	3005	339.6	1488	168.1	7/16, 1/2	---	5/8	3/4	3/4
7/16					9/16	3/4		---	---
1/2					5/8	---	---	7/8	1
9/16					---	---	---	1, 1-1/8	---
5/8					3/4	---	---	1-1/4, 1-3/8	1-1/4
3/4					7/8, 1	---	---	1-1/5	---
7/8					1, 1-1/4	---	---	---	---
1					1-3/8, 1-1/2	---	---	---	---
1-1/4					1-3/4	---	---	---	---
1-1/2					2	---	---	---	---
1-3/4					2-1/4	---	---	---	---
2-1/4					3	---	---	---	---
<b>Metric</b>									
1.27			3	3.4	1.4	---	---	2.5	---
1.5	13.1	1.5	5	0.6	1.6, 2	---	---	3	---
2	33	3.7	13	1.5	2.5	3	3	4	---
2.5	63	7.1	33	3.7	13	1.5	2.5	5	---
3	106	12.0	52	5.9	4	5	5	6	5
3.5			70	7.9					
4	264	29.8	131	14.8	5	6	6	8	6
4.5									
5	483	54.6	247	27.9	6	8	8	10	8
5.5									
6	855	96.6	396	44.7	8	10	10	12	10
7									
8	1861	210.2	989	111.7	10	12	12	14, 16	12
9									
10	3563	402.6	1591	179.7	12	14, 16	14, 16	18, 20	16
12					14	18, 20	18, 20	22, 24	20
14					16, 18	22, 24	22, 24	---	---
17					20, 22	---	---	---	---
19					24, 27	---	---	---	---
22					30	---	---	---	---
27					36	---	---	---	---







\*\* Minimum torque capacities Bondhus® tools generate without breakage.  
Other manufacturer's tools may break with considerably less torque

# Technical Library

## Torque and Screw Interchangeability (continued)

### Torx® Screws

Bondhus® BallStar™ keys fit all of the following screw types

Size											
	Pan Head		Flat Head		Socket Head		Socket Button		Truss Head		Fillster Head
	Inch	Metric	Inch	Metric	Inch	Metric	Inch	Metric	Inch	Metric	Inch
1	---	M0.9	---	M0.9 & M1	---	M0.9	---	---	---	---	---
2	---	M1	---	M1.2	---	M1	---	---	---	---	---
3	---	M1.2	#0				---	---	---	---	---
5	#0	M1.4 & M1.6	#1	M1.6 & M1.8	---	M1.4 & M1.6	---	---	---	---	---
6	#1	M1.8 & M2	#2	M2	#0	M1.8 & M2	#2	---	#2	---	#1
7	#2	---	---	--	#1	---	#3	---	#3	---	#2
8	#3	M2.5	#3 & #4	M2.5	#3 & #4	M2.5	#4	M3	#4	---	#3
10	#4 & #5	M3	#5 & #6	M3	#4 & #5	M3	#5 & #6	M3.5	#5 & #6	M3.5	#4 & #5
15	6	M3.5	#8	M3.5	#6	M3.5	#8	M4	#8	M4	#6
20	#8	M4	#10	M4	---	---	---	---	#10	M5	#8
25	#10	M5	#12	M5	#8	M4	#10	M5	#12	---	#10
27	#12	---	1/4	---	#10	M4.5 & M5	1/4	M6	1/4	---	#12
30	1/4	M6	---	M6	1/4	M6	---	---	5/16	M6	1/4
40	5/16	M8	5/16	M8	---	M7	5/16	M8	3/8	M8	5/16
45	3/8	---	3/8	---	5/16	M8	3/8	M10	7/16	---	3/8
50	7/16	M10	7/16 & 1/2	M10	3/8	M10	---	---	1/2	M10	7/16
55	1/2	M12	9/16 & 5/8	M12	7/16 & 1/2	M12	1/2	M12 & M14	9/16 & 5/8	M12	1/2 & 9/16
60	---	---	3/4	---	9/16	M14	5/8	M16	3/4	---	5/8
70	---	---	---	---	5/8	M16	---	---	---	---	3/4
80	---	---	---	---	3/4	M18	---	---	---	---	---
90	---	---	---	---	---	M20	---	---	---	---	---
100	---	---	---	---	7/8 & 1	M22 & M24	---	---	---	---	---

\*Torx is a registered trademark of Camcar Div/Textron, Inc.



# Technical Library

## Hex Key Torque Comparison

Tool Size	Bondhus® Protanium® Steel		Eklind		Allen							
	Inch	in-lb	Nm	in-lb	Nm	in-lb	Nm					
.050	7.9	0.9	5.8	0.7	6.1	0.7						
1/16	15.9	1.8	10.8	1.2	12.1	1.4						
5/64	34.0	3.8	23.0	2.6	23.0	2.6						
3/32	51.0	5.8	41.0	4.6	40.0	4.5						
7/64	84.0	9.5	65.0	7.3	64.0	7.2						
1/8	129.0	14.6	99.0	11.2	98.0	11.1						
9/64	185.0	20.9	141.0	15.9	144.0	16.3						
5/32	265.0	29.9	202.0	22.8	182.0	20.6						
3/16	431.0	48.7	334.0	37.7	312.0	35.3						
7/32	673.0	76.0	547.0	61.8	498.0	56.3						
1/4	950.0	107.4	819.0	92.5	759.0	85.8						
5/16	2022.0	228.5	1526.0	172.4	1479.0	167.1						
3/8	3005.0	339.6	2498.0	282.3	2345.0	265						
Tool Size	Bondhus® Protanium® Steel		Eklind		Allen		Eight		Wiha		Hafu	
	Metric	in-lb	Nm	in-lb	Nm	in-lb	Nm	in-lb	Nm	in-lb	Nm	in-lb
1.5mm	13.1	1.5	9.5	1.1	9.4	1.1	12.8	1.4	11.6	1.3	9.7	1.1
2	33.0	3.7	23.0	2.6	24.0	2.7	24.0	2.7	28.9	3.2	24.2	2.7
2.5	63.0	7.1	46.0	5.2	45.0	5.1	59.0	6.67	57.0	6.4	52.0	5.9
3	106.0	12.0	83.0	9.4	82.0	9.3	105.0	11.7	101.0	11.4	96.0	10.8
4	264.0	29.8	213.0	24.1	192.0	21.7	227.0	25.6	255.0	28.8	202.0	22.8
5	483.0	54.6	397.0	44.9	366.0	41.4	457.0	51.6	508.0	57.3	403.0	45.5
6	855.0	96.6	672.0	75.9	627.0	70.9	778.0	87.9	835.0	94.3	600.0	67.8
8	1861.0	210.3	1591.0	179.8	1481.0	167.4	1440.0	162.7	1790.0	202.2	1295.0	146.3
10	3563.0	402.6	3087.0	348.8	2951.0	333.5	3547.0	400.7	3440.0	388.7	3130.0	353.6

# Technical Library

## Laboratory Test Report: T-Handle Torque

Project number 3018 99-07600  
Date: March 3, 1999  
MAXIM TECHNOLOGIES, INC.  
662 Cromwell Avenue  
St. Paul, Minnesota 55114

### Project: Torque Testing

Client Purchase Order Number: Verbal  
Prepared By: Scott W. Britzius Project Engineer/Experimental Mechanics - Mechanical Engineering Department  
Reviewed By: Richard S. Alberg Manager - Mechanical Engineering Department  
Phone: (651) 659-7307

"An Affirmative Action, Equal Opportunity Employer"

The test results contained in this report pertain only to the samples submitted for testing and not necessarily to all similar products.

### Comparison Performance Torque Testing

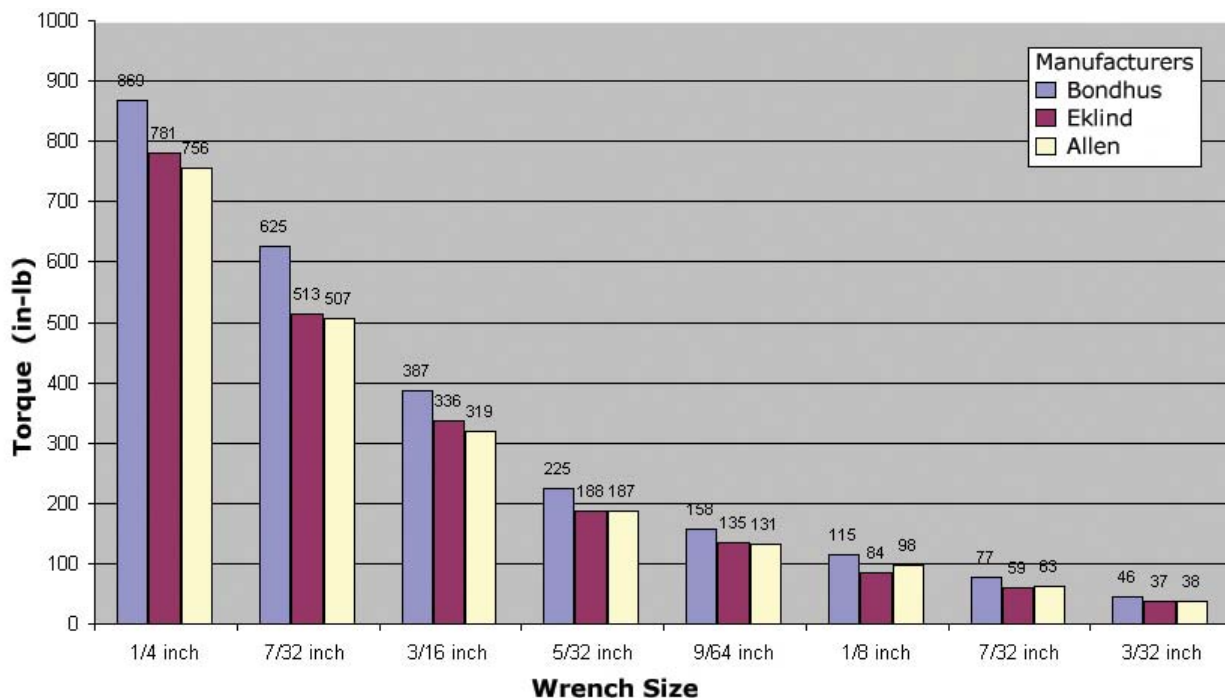
#### INTRODUCTION:

This report presents the results of comparison performance tests conducted on T-Handle Hex wrenches produced by three manufacturers. The testing was requested on March 3, 1999 by Mr Mike Blackston of the Bondhus® Corporation.

The scope of work was limited to purchasing the two competitor brand of wrenches directly from an industrial distributor. Determining the torque required to fracture (break) the three manufacturers wrenches and to provide a report of the results.

#### SUMMARY OF RESULTS:

Average Torque to Fracture (break) Off Wrench, in-lb



## Laboratory Test Report: T-Handle Torque (continued)

### SAMPLE IDENTIFICATION:

T-Handle style Hex Wrenches. The Bondhus® wrenches were submitted on 3-4-99. Maxim Technologies purchased from MSC Industrial Supply Company, five (5) wrench sets of: ALLEN -Cushion Grip P/N 75043513 and EKLIND - Wire Form P/N 05044516 under our Purchase Order number 52205 dated 3-10-99. The wrenches were received at our facility via UPS on 3-12-99. The wrench sizes, shank length and T-handle dimensions are listed below.

Wrench Size	Bondhus®				Eklind			Allen		
	Shank Length	Handle Width	Diameter	Part #	Shank Length	Handle Width	Diameter	Shank Length	Handle Width	Diameter
1/4 inch	5.8	4.1	0.7	13312	3.1	4.1	0.9	5.4	5.0	0.65
7/32 inch	5.3	4.1	0.7	13311	3.1	4.0	0.8	5.4	4.2	0.65
3/16 inch	4.8	4.1	0.65	13310	3.1	4.0	0.7	5.4	4.2	0.65
5/32 inch	4.6	3.1	0.5	13309	3.0	3.1	0.65	5.6	3.1	0.45
9/64 inch	4.3	3.1	0.7	13308	3.0	3.1	0.6	5.6	3.1	0.45
1/8 inch	4.0	3.1	0.5	13307	6.0	3.1	0.6	5.6	3.1	0.45
7/32 inch	3.8	3.1	0.5	13306	6.0	3.0	0.5	5.6	2.4	0.45
3/32 inch	3.5	3.1	0.5	13305	6.0	3.0	0.5	5.6	2.4	0.40

### TEST METHODS:

The size, shank length, handle width and diameter of the wrenches were documented. The torque testing was conducted by placing the shank of the wrench into the matching size of a hex driver socket attached to a 2,000 in-lb torque transducer. The handle of the wrenches were rotated in the clockwise direction using a fixture (see drawing on page 6) designed to contact the handle with two (2), 3/8" diameters on opposite sides, at the span of; 2" for the 5/23" - 3/32" wrenches and 2-1/2" for the 1/4" - 3/16" wrenches. The wrenches were torqued until either the shank fractured (broke), spun loose in the handle or handle deformation caused loss of contact with the torque fixture. The indicated maximum peak torque and mode of break were documented for the wrenches.

### TEST EQUIPMENT:

Lebow 2000.0 in-lb torque transducer, MTI# MM 120-002, calibrated traceable to the NIST on 2-3-98 due 2-3-00.

# Technical Library

## Laboratory Test Report: T-Handle Torque (continued)

### TEST DATA:

Torque to Break Wrench, in-lb. Mode of Failure (see table below)

Wrench Size	Manufacturer	Trial Number					Average Torque
		#1	#2	#3	#4	#5	
1/4"	Bondhus®	857	840	880	881	888	869
	Eklind	832	759	777	681	855	781
	Allen	751	747	750	770	763	756
7/32"	Bondhus®	624	598	631	630	641	625
	Eklind	521	518	520	504	503	513
	Allen	506	506	511	511	503	507
3/16"	Bondhus®	400	390	381	383	380	387
	Eklind	333	324	343	341	339	336
	Allen	330	329	314	311	311	319
5/32"	Bondhus®	221	224	234	223	221	225
	Eklind	190	188	189	183	188	188
	Allen	193	184	189	186	184	187
9/64"	Bondhus®	160	152	161	159	158	158
	Eklind	137	136	137	135	131	135
	Allen	131	130	131	131	130	131
1/8"	Bondhus®	105	114	118	114	119	115
	Eklind	89	85	82	82	82	84
	Allen	97	101	94	99	101	98
7/64"	Bondhus®	78	77	77	76	79	77
	Eklind	62	55	60	60	60	59
	Allen	63	60	63	64	62	63
3/32"	Bondhus®	46	45	46	45	46	46
	Eklind	38	37	37	36	37	37
	Allen	40	37	37	38	37	38

### Mode of Failure:

Bondhus® and Allen - the shank of the wrenches twisted into a spiral and then fractured.

Eklind - the wire handles deformed resulting in loss of contact with the torque fixture. Twisting and bending of the shanks also occurred during torquing, but no shank fractures occurred.



# Technical Library

## Laboratory Test Report: Hex Key Torque

Project number 3018 99-05234  
Date: January 29, 1999  
MAXIM TECHNOLOGIES, INC.  
662 Cromwell Avenue  
St. Paul, Minnesota 55114

### Project: Torque Testing

Client Purchase Order Number: Verbal

Prepared By: Scott W. Britzius Project Engineer/Experimental Mechanics Mechanical  
Engineering Department

Reviewed By: Richard S. Alberg Manager Mechanical Engineering Department

Phone: (651) 659-7307

\*An Affirmative Action, Equal Opportunity Employer\*

The test results contained in this report pertain only to the samples submitted for testing and not necessarily to all similar products.

### Comparison Performance Testing

#### INTRODUCTION:

This report presents the results of comparison performance tests conducted on eight specified sizes of hex wrenches produced by three manufacturers. The testing was requested on January 4, 1999 by Mr. Mike Blackston of the Bondhus® Corporation. The scope of work was limited to purchasing the hex wrenches directly from an industrial distributor, determining the torque to fracture (twist off) the wrenches and providing a report of the results. The testing was completed on January 27, 1998.

#### SUMMARY OF RESULTS:

Average Torque to Fracture (break) Off Wrench, in-lb

Wrench Size	MANUFACTURERS		
	Bondhus®	Eklind	Allen
1/16 inch	15	11	11
5/32 inch	225	190	160
1/4 inch	920	765	725
5/16 inch	1760	1525	1390
1.5 mm	12	10	9
4 mm	230	165	160
6 mm	760	650	610
8 mm	1710	1540	1440

## Laboratory Test Report: Hex Key Torque (continued)

### SAMPLE IDENTIFICATION:

Ball-end style hex wrenches purchased from MSC Industrial Supply Co. under Maxim Technologies purchase order number 51345 on 1-14-99 and shipped to our facility by UPS. Five (5) wrenches each in the size and leg lengths listed below were purchased.

Size	Length	Size	Length
1/16	1/2 x 3	1.5 mm	1/2 x 3
5/32	1 x 4	4 mm	1 x 4
1/4	1-1/4 x 5	6 mm	1-1/4 x 5-1/2
5/16	1-1/2 x 6	8 mm	1-1/2 x 6

### TEST METHODS:

The size, leg lengths and end styles of the wrenches purchased were documented. The torque testing was conducted by placing the shorter leg of the wrench 3/16" into the matching size of a hex driver socket. The hex socket was attached to a 2,000.0 in-lb torque transducer. To obtain the required leverage to stress the wrench, an extension arm (pipe) was placed over the longer leg to terminating 1 inch from 90° bend. The wrenches were then torqued clockwise until the wrench fractured (broke) off. The indicated maximum peak torque and location of break were documented for each wrench.

### TEST EQUIPMENT:

Lebow 2K in-lb torque transducer, MTI# MM 120-002, calibrated traceable to the NIST on 2-3-98 due 2-3-00.





# Technical Library

## Laboratory Test Report: Hex Key Torque (continued)

### TEST DATA:

Torque to fracture (break) off wrench, in-lb.

Wrench Size	Manufacturer	Trial Number					Average Torque
		#1	#2	#3	#4	#5	
1/16"	Bondhus®	16	15	16	15	15	15
	Eklind	11	11	12	10	11	11
	Allen	10	10	12	11	11	11
5/32"	Bondhus®	239	200	233	243	220	225
	Eklind	195	189	192	192	190	190
	Allen	175	157	150	138	170	160
1/4"	Bondhus®	922	910	950	902	927	920
	Eklind	789	764	754	754	761	765
	Allen	724	720	731	724	719	725
5/16"	Bondhus®	1,789	1,764	1,778	1,735	1,740	1760
	Eklind	1,521	1,513	1,535	1,546	1,501	1525
	Allen	1,371	1,430	1,403	1,371	1,382	1390
1.5mm	Bondhus®	11	12	12	12	11	12
	Eklind	10	9	11	11	10	10
	Allen	9	10	10	9	9	9
4mm	Bondhus®	249	215	231	235	235	230
	Eklind	163	147	182	162	177	165
	Allen	180	132	164	175	148	160
6mm	Bondhus®	786	750	742	758	752	760
	Eklind	653	642	656	640	650	650
	Allen	621	584	613	607	617	610
8mm	Bondhus®	1,733	1,704	1,707	1,693	1,712	1,710
	Eklind	1,535	1,526	1,557	1,543	1,550	1,540
	Allen	1,431	1,426	1,480	1,424	1,428	1,440

In all cases the wrenches broke at the start of the socket driver with permanent twisting of the shorted leg occurred prior to breaking.

### REMARKS:

The wrenches will be retained for thirty days than discarded.

# Technical Library

## Laboratory Test Report: Corrosion Resistance

Date: January 4, 1999  
MAXIM TECHNOLOGIES, INC.  
662 Cromwell Avenue  
St. Paul, Minnesota 55114

### Project: Salt Spray Testing

Client Purchase Order Number: Verbal

Prepared By: Scott W. Britzius Project Engineer/Experimental Mechanics  
Mechanical Engineering Department

Reviewed By: Richard S. Alberg Manager Mechanical Engineering Department

Phone: (651) 659-7307

"An Affirmative Action, Equal Opportunity Employer"

The test results contained in this report pertain only to the samples submitted for testing and not necessarily to all similar products.

### Comparison Performance Torque Testing

#### INTRODUCTION:

This report presents the results of comparison Salt Spray performance tests conducted on 5/16" hex wrenches produced by three manufacturers. The testing was requested on January 4, 1999 by Mr Mike Blackston of the Bondhus® Corporation.

The scope of work was limited to purchasing the hex wrenches directly from an industrial distributor, conducting the salt fog exposure testing and providing a report of the results. Testing was completed on February 4, 1999.

#### SUMMARY OF RESULTS:

Manufacturer	Sample	% Rust after 20 hours exposure	Type & Location of Rust
Bondhus®	A	3 to 5%	3 to 4 pin head size red rust spots.
	B	3 to 5%	3 to 4 pin head size red rust spots.
Eklind	A	60 to 70%	Red rust and pitting of surface.
	B	60 to 70%	Red rust and pitting of surface.
Allen	A	70 to 80%	Red rust and pitting of surface.
	B	70 to 80%	Red rust and pitting of surface.

#### SAMPLE IDENTIFICATION:

Two (2) wrenches each were purchased from MSC Industrial Supply Co. under Maxim Technologies purchase order number 51345 on 1-14-99 and shipped to our facility by UPS.

Bondhus®: 5/16" Hex Wrench, 1-1/2 x 6" with ball end.

Eklind Tool: 5/16" Hex Wrench, 1-1/2 x 6" with ball end.

Allen: 5/16" Hex Wrench, 1-1/2 x 6" with ball end.



## Laboratory Test Report: Corrosion Resistance (continued)

### TEST METHODS:

The test was conducted in accordance with ASTM:B117-94. The samples were tested as received with no cleaning prior to exposure. The wrenches were supported at a angle of 15° from vertical for 20 hours under the following conditions:

Test Media:	5% Salt solution
Cabinet Temperature:	95° F
Fog Collection (ml/hr):	1.2 to 1.3
Specific Gravity:	1.037
pH Range:	7.0
Humidifier Temperature:	110° F
Tower Pressure:	12 psig

### INSTRUMENTATION:

Salt Spray Chamber #2, MTI# MM 190-007, calibration traceable to the NIST on 6-4-98 due 6-4-99.

### REMARKS:

The wrenches will be retained for thirty days than discarded.

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Investigative Chemistry Geotechnical Construction Materials  
Non Destructive Testing Failure Analysis Product Evaluation  
Metallurgical Analysis Materials Testing Welder Qualification

**TORQUE TEST OF  
6mm HEX TOOLS**

Prepared for:  
BONDHUS CORPORATION  
Attn: Mr. Mike Blackston  
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Monticello, MN 55362

Client Purchase Order Number: 6-8-MB

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Product Evaluation Department

The test results contained in this report pertain only to the samples submitted for testing and not necessarily to all similar products.

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Twin City Testing Corporation

PROJECT NUMBER: 30160 06-77182

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DATE: June 16, 2006

### INTRODUCTION:

This report presents the results of the torque testing of 6mm Hex Tools. Mr. Mike Blackston of the Bondhus® Corporation submitted the samples to our laboratory on June 8, 2006.

The scope of our work was limited to determining the ultimate torque required to twist-off the hex tools and to provide a report of the results. The testing was completed on June 15, 2006.

### SAMPLE IDENTIFICATION:

Four (4) 6mm Hex Tools in their original packages from the following Manufacturers were submitted for testing.

ASAHI Tools (Japan)	DX2000 (AQ-0600) 6mm Hex Key Wrench	Ball Point Type
Bondhus® (USA)	6mm Ballpoint L-Wrench	Part# 10968
Eight Brand (Japan)	6mm Taper Head Hexagon Key Wrench	TL-6
PB Baumann (Switzerland)		212L-6
Wiha (Germany)	Hex L-Key long arm Nickel Plated 6mm	Part# 35211

### SUMMARY OF RESULTS:

The maximum torque required in inch pounds (in-lb/NM) to fail the hex tools were as follows:

Tool	Manufacturer				
Sample	ASAHI	Bondhus®	Eight Brand	PB Baumann	Wiha
#1	710 – 80.2	860 – 97.2	785 – 88.7	810 – 91.5	660 – 74.6
#2	680 -76.8	850 – 96.0	790 – 88.3	790 – 89.3	800 – 90.4
#3	700 – 79.1	850 – 96.0	780 – 88.1	780 – 88.1	730 – 82.5
#4	700 – 79.1	840 – 94.9	770 – 87.0	790 – 89.3	790 -89.3
Average	700 – 79.1	850 – 96.0	785 – 88.7	790 – 89.3	745 – 84.2

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### TEST METHODS:

The torque testing was conducted by inserting the short arm of the tool into a 6mm socket (1/4" deep) connected to a 2,000 in-lb torque sensor. An extension tube was then placed over the long arm for increased leverage and the tool twisting clockwise. The first sign of twisting and the maximum torque obtained along with the mode of failure was documented for each tool sample.

### TEST EQUIPMENT:

Lebow 2,000 in-lb Torque Sensor accuracy verified with Stork-TCT Torque Wrench No: MM120-007, NIST traceable calibration on 4-7-06, due 4-7-07

### REMARKS:

The hex tools were returned to the Bondhus® Corporation following the testing.

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