



5 Things About Miniature Screws

微小螺絲製造與應用

by Laurence Claus

Humans seem to be fascinated with anything outside the norm. Everybody seems to marvel at things of immense size, like those big tractor tires that a grown man can fit inside, the world's largest ball of twine, and the Great Wall of China. Equally fabulous, though, are things that are very small. In fact, the Guinness Book of World Records seems to have an endless number of record small things.

Screws and fasteners, like many other items, also come in very small sizes. In fact, there are threaded fasteners that are so small it is difficult to make out their features with the naked eye. Of course, it makes sense that there would be an abundant variety of miniature fasteners, since small assemblies must be held together just like their larger counterparts. Therefore, although they come in tiny packages, they are expected to perform in a big fashion.

However, any purveyor or user of these miniature products likely can attest to the challenges they pose. Again, they may be small but often pose big challenges in manufacturing and assembly. This article is devoted to exploring five things about miniature screws and fasteners.

One: Where are they used?

The simple answer to this is that they are used everywhere. In fact, just about everyone probably has products they use on their person that contain miniature screws. Common

items might be watches, eye glasses, hearing aids, and smart phones. Besides being on your person they are in all types of other items we take for granted as well. It doesn't take long to glance around one's living space to find items that contain such small fasteners. They are in cameras, computers, thermostats, the electronics in our automobiles, and even the toys our children play with.

The products are as wide and varied as their larger cousins. There are simple screws formed on single-die-double-stroke headers and more complex parts formed on two-die-three-blow headers. The thread forms come in a wide variety and may be simple machine screw threads or thread forming threads designed for a special purpose like fastening into plastic or aluminum. Parts may come with SEMS washers assembled to them, possess shoulders for shoulder screws, be heat treated, and plated with a variety of different finishes.

Figures 1 through 9 represent a gallery of typical miniature fasteners. In this simple selection, one can see the variety of product types and sizes and imagine the wide range of uses of such fasteners.

Two: Challenges in Assembly

Miniature fasteners present a variety of challenges to the engineers engaged in assembly. These challenges fall into three main categories, handling, feeding, and assembly.



Figure 1: Miniature Collared Pin or Axle ($\varnothing = 0.016''$)



Figure 2: Knurled Pin for Laptop Computer



Figure 3: M 1.6 SEMS Screw



Figure 4: Square Head with Internal Back Extruded Shank



Figure 5: Shoulder Screw for Computer (Blank-Not Threaded Yet)



Figure 6: Pin with Shoulder



Figure 7: Pin with Shoulders



Figure 8: Pin with Shoulders



Figure 9: M0.8 Screw for Watch

Handling:

In general, the handling of screws can be a challenge in a production environment, but gets multiplied by several magnitudes of difficulty as parts get smaller. Imagine an entire order of many thousands of screws fitting into the equivalent of a Styrofoam coffee cup. This is an impossibility for screws in, say the M4 range, but may not be for one that is, say an M1. This creates a variety of handling challenges because the ease for loss and spillage is greatly increased. With a normal sized part a simple spill is a nuisance but normally results in the loss of only a few screws. With miniature screws, however, a simple spill could result in a loss of a significant quantity of screws. If such spills are not reported, such a loss could result in stock loss issues and lost production at a later date.

Packaging can also prove to be challenging with miniature fasteners. If the parts are very small it may not be appropriate to package them in a normal sized shipping box because they will not fill up enough space and they risk falling out or between the folds in the box. This means that they must be specially packaged in plastic bags or much smaller boxes. This may provide a good solution for shipping between the manufacturer and the end user, but may still not be ideal if the parts are not completely consumed in production and have to be placed back into a container for storage until the next time they are to be used.

Feeding:

Feeding small parts can be especially challenging. Aligning small parts in the proper orientation can be a challenge, which subsequently makes them difficult to automatically feed. On the other hand, manual selection of parts from a tray or bin can be equally challenging. Because they are so small they are difficult to pick up with your fingers and the use of aids such as magnetic bits can be impractical because they indiscriminately pick up multiple parts at one time. Again, these problems are intensified when the part is extremely small or the ratio of the head to the length of the shank or thread is very close. (In such cases, it may be difficult to guaranty that the part will align or orient itself in a predictable and desirable fashion.)

Assembly:

The assembly process with miniature fasteners can get tricky. Again, this is a function of decreasing size of the part. Two significant challenges exist. The first is with engagement of the drive. Almost all

of these miniature screws are driven by internal recesses. Naturally, on a very tiny screw, the recess must be very tiny. This leads to challenges with engagement and “bit stick”. Engagement issues can be particularly challenging when using an automated assembly or one where an already rotating bit is attempting to find the recess. Ultimately, poor or difficult engagement leads to lengthy assembly cycles or cammed-out recesses. When manually picking and assembling miniature screws “bit stick” becomes an important feature. This is when the recess and/or bit have a feature to hold the screw in-place and unsupported during the movement from feedstock bin to joint. In other words, it prevents the screw from falling off the tip of the bit, an important advantage with very small screws because of the difficulty retrieving them if they fall off.

The second challenge is having a driver that is capable of controlling torque for such tiny joints. There are a variety of manufacturers that make such equipment. The bottom line, however, is that it does take special and precise drivers and controllers to successfully make these joints.

Three: Challenges in Manufacturing

For the most part, the same challenges that are present to the user also exist for the manufacturer. In the same way that spillage and handling are important factors for the end user, they are even more critical to the manufacturer. The manufacturer must successfully transfer parts between several manufacturing stages, in particular heading and thread rolling. The chances for loss are great.



Feeding is also an issue in manufacturing. After parts are headed they often require a thread rolling process. A thread roller is fed by parts being pushed through a rail or channel. This rail is almost always loaded by a vibratory bowl. In this process the parts are randomly placed in the vibratory bowl, shuttled to the top, and oriented to feed into the rail. Parts that are not oriented correctly simply fall back into the bottom of the bowl for another try. When parts are short or are close in length to their diameter (or the diameter of the head), getting them to orient properly is challenging. Therefore, miniature parts that are also very short are particularly difficult.

Additionally, parts can get hung up in the feed rails if they are not very

heavy and there is the presence of oil. The oil, especially if it is higher in viscosity, actually can hold the part to the rail. This is not an issue with heavy parts, but can be with lighter parts, or in this case, very small ones.

The final challenge for the manufacturer is inspection and validation. Some of these parts are difficult to distinguish with the naked eye and features are so tiny that checking dimensions in a conventional manner is nearly impossible. One must employ special care in measuring these types of parts and it must be done on equipment, such as a comparator or tool maker's microscope, that allow the part to be magnified for capable measurement.



Four: Challenges in Heat Treating and Plating

Normal commercial heat treating and plating processes depend on weight for effective processing. What does one do when the entire order or lot of parts can fit into the palm of your hand? How does one keep from losing all of the parts in furnace nooks and crannies or through the holes in a plating barrel? This, of course, is the challenge for the processor of such small parts. Normally special "pouches" or bags have been created that retain the parts and prevent them from loss during the heat treating process. Likewise, it would be impossible to plate parts in normal production sized barrels, and, therefore, such parts are normally processed in much smaller barrels intended for small lots or prototypes. Just as for the manufacturer, measurement is tricky and must be done with methods that magnify the parts.

Five: Pricing

For most normal sized product, especially if it is considered a commodity, one can usually derive some sort of relationship between the material

content and the price. In this way one might say, for example, such and such a product is normally about "X" times material cost. However, the material in these miniature screws, even if it is an expensive material like stainless steel or copper, is almost negligible when compared to the processing costs as has been explained above. Therefore, it is not at all uncommon to find a miniature fastener costing many times that of a much larger fastener even though the raw material in the screw is much less.

Conclusion:

Miniature screws and fasteners are a real marvel. They can be as sophisticated as their larger counterparts but take much greater care and exacting effort to manufacture. Not every manufacturer possesses the skill and capability to make such parts and when purchasing such screws it is probably prudent to purchase them from a source that is specifically skilled and experienced in this size and type of product. ▣