Twist Pattern Development in Mokumé-gane

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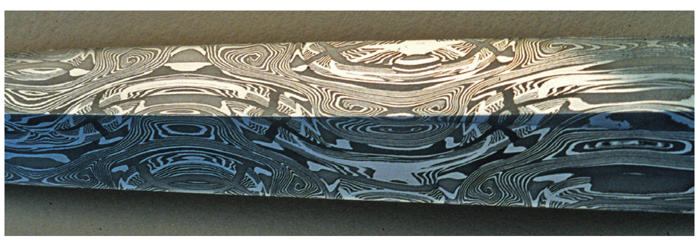
Twist Pattern Development In Mokume-gane

1. 14KPW/Sterling 19 layer rod twist and carved to produce this pattern.

What are twist patterns?

Twist patterns are the class of patterns that are made from multi-layered metal rod by twisting. They often have a rope-like quality, but can take on other appearances. They are the oldest deliberately developed patterns, appearing on sword blades from cultures as far apart as central Europe and Indonesia. Twist patterns have been popular for several millennia with no sign of interest fading in the foreseeable future.



2. Reverse twist pattern with a complex section on a blade. Stock removal played an important part in appearance of the pattern on this side of the blade.

3. Two twist and one flat grain rods joined side by side on a blade. Note the differences in the tightness, direction and other aspects of each rod.

What can I do with them?

Twist patterns, because they are made from rod are always linear in form. The best application of twist patterns are for pieces that use a band or rod form such as bracelets, rings and decorative borders. Several twist rods may be placed side to side to form a broader surface. It is possible to cross roll a twist rod to form a square sheet, but this is difficult, time consuming and the result is often not terribly attractive for the effort expended.

4. Three different twist pattern bracelets. Top: silver/copper/shakudo, two opposing twist rods, stock removed on edges. Center: Palladium/sterling reverse twist. Bottom: Silver/shakudo irregular twist.

Are there different types of twist patterns?

Twists can have many different aspects. They may be right or left handed, have a tight or loose pitch, be regular, irregular or reversing. An interesting aspect of twist patterns is that they change depending on how much material is removed from the surface after twisting. The surface of the twist rod has a rope-like pattern; if the same rod is split lengthwise, the center section will have a star-like pattern with each star corresponding to one half a full rotation of the rod. The internal patterns may be varied by using rods with a layer arrangement other than flat, parallel layers.

5. Left: Inside star pattern on twist rod, silver, shakudo, shibuichi. Right: surface pattern of the same twist rod. Note the “drag over” of silver onto the alloy surface due to sloppy finishing.

6. Rod composed of four alternating layers of vertical and horizontal grain, twist and cut in half to show center pattern. Classic Japanese style mokume with rokusho patina.

Mechanical and Geometric Considerations

There are some important mechanical considerations in twisting rod. As a rod is twisted, the very center of the rod undergoes no stress at all, while the outer surface is stretched longer as it coils around the core. Experimental evidence seems to indicate that the rod length remains unchanged, therefore all deformation of the metal would be in the form of stretching, as if it was being pulled longer. The greater the distance from the center, the greater the relative stress.

A round rod that is twisted would show no stress differential from twisting on the surface. A square rod, by contrast, would show a marked stress differential between the center of the surface faces and the corners. This stress differential results in a distortion of the square section. as shown by the example. Hammering of the raised corners after twisting often results in cold shuts on the surface. In addition, the high stress differentials on the surface coupled with different work hardening characteristics of the mokume layers can lead to possible material failure. Twisting produces one of the greatest possible stresses on any metal, with reverse twisting being the most severe. Care must be taken to reduce the stress on the material caused by twisting to minimal levels.

Twisting a rod that is the minimum size needed to produce the patterned stock needed is helpful. The section of the rod should be a close to a round as is possible; an octagon section works well if a round is not practical. Keeping the rod in tension while twisting prevents the introduction of bends and kinks that can cause material failure during straightening. Sensitivity to work-hardening is important; anneal the rod before it work-hardens to the point of fracture.

Doing the Twist

General Considerations: Before starting material manipulation, it is helpful to estimate the amount of metal needed. To determine the metal needed, find the volume necessary for fabrication (multiply length x width x thickness) and multiply this number by 1.1 to 1.2.

This multiplier is to account for metal lost in forming the twist rod into a usable strip or other section. Divide this product by the section of the rod to be used and this will give the length. Be sure to add at least one rod diameter to each end for gripping because these are often so mangled as to be unusable. An example is given below.

The project is a bracelet.

The mokume needed to start fabrication is a piece 3/8” x 14ga x 5” or in decimal measurements .375” x .064” x 5”= .12 cubic inches (in^3) x 1.2 = .144 in^3. If 3/16” rod is used square the dimensions of the rod to find its area, .1875” x .1875” = .03515 in^2. Divide the volume needed by the area of the rod to be twisted to determine the length or .144 in^3 ∏ .03515 in^2 = 4.096”. Add 3/16” (.1875”) to each end for gripping and the total length needed is 4.472” or about 4 1/2”. Observing the starting length compared to the ending length, it can be seen that almost all the manipulation of the rod after twisting will be in the form of spreading. This is likely to result in a good, tight twist pattern, assuming a moderate twist of about 45°.

7. Sterling/copper rod, actual dimensions are 5/16” octagon x 5” long. Note the gripping area on the ends. This twist is quite tight, about 75°.

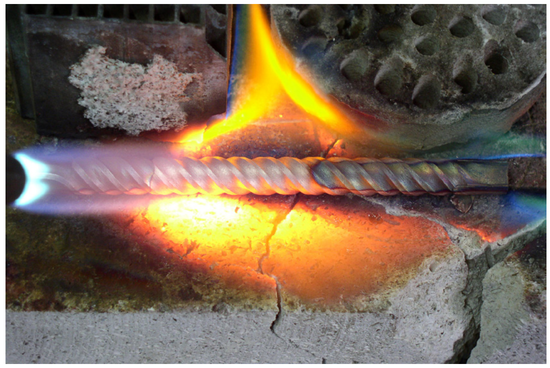
As a practical matter it is very difficult to twist a rod that is less than 4 to 6 thicknesses long. Waste can be reduced by twisting material to be used for more than one object at a time because the same amount is used for gripping on the ends. Determining the desired dimensions of the rod to twist is often best determined by experiment; try twisting using copper or soft aluminum rod to find the optimum dimensions.

8. A vertical mill on a slow back gear works well for twisting this 5/16” stock.

Cold Twisting

Cold twisting works best on rod under 1/4” thick or when one has access to machinery that can apply greater force than possible by hand, such as a slow back gear on a metal lathe.

Before twisting, be sure the stock is well annealed. Clamp one end of the rod, gripping about one diameter of the stock in a vise. Grip the other end with vise grip pliers or some other strong gripping tool and rotate. Be sure to keep a tension on the rod to prevent kinking or bending. When the rod becomes stiff from work-hardening, remove it from the vice and anneal. Take care not to over-anneal, either too hot or too long. Do not quench the rod from the annealing temperature, let air cool to a black heat (no color in a dark room) in air before more rapid cooling.



9. Annealing using an acetylene/air torch.

After annealing, continue twisting and annealing as needed until the desired tightness of twist is reached. As a rule of thumb the minimum pitch of the twist should be about 45°. Twist rods that have less than 45° pitch tend to have very open patterns after shaping the twist for fabrication. Twisting past an 80° pitch runs the risk of breaking the rod. Apparent pitch may be increased by spreading or cross rolling the rod perpendicular to its axis after twisting.

After the desired tightness of twist is achieved the rod should be inspected and annealed for subsequent shaping. A fair amount of practice is needed to get a feel for when the rod is ready to anneal. Practice with a homogeneous rod of lesser expense is highly recommended.

Hot Twisting

WARNING!

Hot working is not recommended! These metals are often "Hot Short" which means they are brittle when hot. The manufacturer and supplier will take no responsibility for materials worked hot.

Hot twisting is generally used when the rod is either too stiff or too thick to twist cold. The process is inherently more risky than cold twisting due to the inability to control the heat with precision and the close proximity of the hot-plastic and hot-short temperatures of many jewelry materials. Mokume with known hot short components should not be hot twisted, these include silver/copper combinations and anything with Shibuichi. Sterling with 14K Palladium White Gold and 22K Gold can be hot twisted as well as most types of bronze mokume.

10. Set-up for hot twisting.

To start, clamp one end of the rod in the vice, the same as with cold twisting. Grasp the other end with tongs or vice-grip pliers and apply a light twisting force. Heat the rod with a torch, maintaining the twisting pressure.

A suitable heat source is a hand held torch. A fair amount of heat is needed, oxygen/propane, air/acetylene and oxy/acetylene all work. Be careful not to direct the hot tip of the flame cone on the rod, this can cause excessive local heat that can melt or weaken the rod. Use the tail of the flame past the tip of the flame cone, keeping the flame moving.

When the rod is heated to the correct temperature it will start to twist with relatively little pressure, one will feel it “give” in the hand. Take the flame away from the rod and continue twisting, putting the flame on the rod only when one feels the rod start to loose its plasticity. For longer twists, heat more length or do a series of short twists. Reverse twisting may be done hot or cold but with a very high risk of layer tearing and separation. After the desired degree of twist has been obtained, pickle and wire brush the rod in preparation for further manipulation.

Repairs

It is important to distinguish between different types of material breakdown. Layers can separate from one another or individual layers can tear inside but parallel to weld lines. Layer separation is easily repaired. In another type of material breakdown, layers or whole rods can fracture across the grain. This type of breakdown is almost always caused by overheating at some point in the manipulation process, frequently during hot twisting. Fracture-type breakdown cannot be repaired without degrading the pattern.

Minor layer separation due to the stress of twisting is common, even in perfectly flaw-free stock. Most often the separations occur during the first forging of the rod after twisting and annealing. If forging the twist rod to a rectangular section, the separations are most likely to appear on the two narrow or edge faces. Stop forging, except to even up the different parts of the rod. Flux the open separations and bring the rod to a soldering heat. Fill the cracked areas with a suitable solder, one with a flow temperature lower than the melting point of the mokume. Medium silver solder works well for mokume with sterling and some other component, medium or hard yellow or white gold solder for straight gold mokume. Use only enough solder to close the joint. Be sure to use the proper karat of solder for gold pieces that are to be quality marked. Capillary action will draw the flux and solder into the small voids and prevent further tearing of the layers.

After soldering, let the work air cool, then pickle until clean. Remove excess solder by sanding or filing. Continue forging to the desired form, annealing as needed. If another separation occurs, repeat the soldering sequence. Continue forging until the desired form is achieved. Additional fabrication operations, such as prong attachment, may be performed using the same or lower temperature solders. The soldered gaps are usually not noticeable in the finished work.

Summation

Twist patterns have a rhythmic quality with structural similarities to other materials from vines to the DNA molecule. If properly done, they can produce visually compelling patterns without the high amount of metal loss associated with incised patterns. Large twist bars, slab cut in cross section, can produce interesting arrangements of layers. Twist pattern development has the benefit of producing patterns that do not have a wood grain quality and can take mokume into a different graphic realm.

Have fun experimenting and show the world what you have done.

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