Mokume Gane - One Quarter at a Time

Steve Bloom

Mokume gane is Japanese for 'wood grain' and is, essentially, non-ferric Damascus forge-welded material. If you can get a slab of the material with multiple layers, you can use pattern manipulation to generate pleasing patterns and to dress up a knife.

A common mix is fine silver and pure copper. The traditional (and probably the best way) to make the stuff is to slip a stack of alternating and absolutely clean material into a torque plate (think two slabs of steel that bolt together around the stack), stick the torque plate into a stainless steel bag, and shove the assembly into a temperature controlled oven (think Paragon) at a temperature just under the melt temperature of the lowest melting material. Wait for a day or so and hope the material has bonded. A detailed explanation can be found in Ferguson (2002) or Midgett (2000).

Being smiths (impatient, cheap, clever....), somebody realized that US coinage might represent an alternative. The material in "silver" coins is actually a layer of copper between two layers of cupronickel (70% copper, 30% nickel). If a stack of coins can be brought to the correct temperature, they can be welded together to make a source of mokume gane substantially less expensive that working with fine silver.

In the demo I saw at a FABA conference a few years back, the demonstrator used a pair of tongs to hold the stack in the forge. When they began to 'sweat', they were quickly hammered and fused together. Recently, I started playing with this idea - after all, how hard could it be?

I started by altering a set of tongs to hold a stack of 12 quarters ($3.00 or approximately 0.75"). The jaws have to be set parallel to one another so that the stack stays aligned. The jaws also have to be coated with an anti-flux (like yellow ochre powder) so that the coins won't stick to the jaws of the tongs. What I discovered is that if the stack is not perfectly aligned and/or the tongs are not held perfectly during what seems like an interminable time while waiting for the sweat to appear, there will be a tendency for some of the coins to partially slip out. When that happens, the stack may not fuse correctly and some mangled quarters get to join the scale around the power hammer. You also have to reset the tongs each time since they get whacked by the hammer during the process.

It took only a couple of trials before I realized that there was a better way (the black mark on the forehead of a smith isn't about Ash Wednesday - it comes from slapping yourself in the head and saying "DUH!"). Drill a hole in the center of the coins and rivet them with a copper rivet. The coins stay aligned, the tongs do not need to be readjusted since they are never hammered and the time in the forge drops considerably since the tongs are not there sucking up heat.

The problem then was - how to make the hole? You can drill each one (use a center-finder or use a template to position the center punch, then hold it while drilling). You can also find a convenient copper pipe (ID less than 0.95", the diameter of a quarter), cut it to the length of the stack-to-be, slit the side, and stack the quarters in it. Clamp the assembly in a drill press vise and drill the stack. Obviously, the first process involves a lot of repetitive steps and the second (depending on the drill press and the diameter of the rivet) may result in the hole "wandering" such that the riveted stack leans a bit.

There is an alternative. At a recent FABA meeting, an old Whitney punch (a 7A - henceforth referred to as the 'tool') was contributed to the Iron-in-the-Hat. I acquired it, cleaned

Figure 1: The punch

it up and painted it as well as ordering some new dies and punches (1/8") (Figure 1). The way these guys work is that the die is installed in the upper section while the punch threads into the lower section. Typically, the punch has to extend a bit above the lower section to allow the die to penetrate sufficiently to actually punch the hole. In this particular tool, the punch thread is 3/4x16 and I happened to find a nut to match (that's why you keep all of those odd-and-ends, isn't it?).

The nut was tossed onto the lathe and a recess the size of a quarter was cut into it. The nut was sawed in two, the cut cleaned up, and what you get is shown in Figure 2.

Figure 2: The nut and recess

The nut is threaded onto the top of the punch and a quarter is slipped into the recess (Figure 3). A slap of the hand and the hole is made - centered and no need to deburr. Punching enough quarters to make a stack is now accomplished in a fraction of the time compared to drilling.

The rest of the process is straightforward. Wire brush the

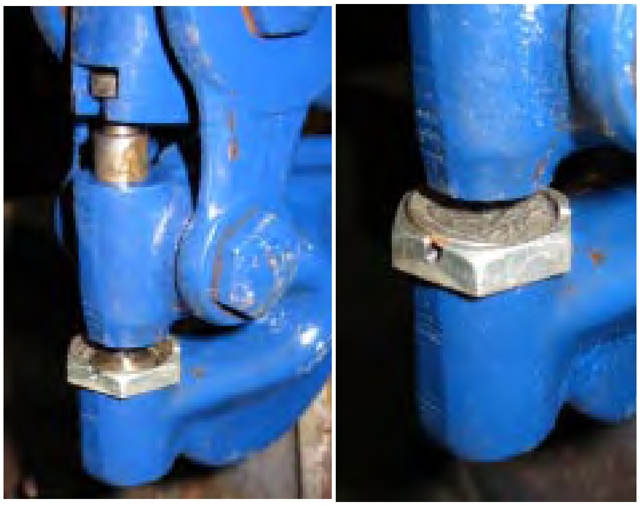

Figure 3: Die & quarter in place

coins and take care not to touch the surfaces with your greasy paws. If you are truly anal, use examination gloves and wipe the coins with acetone. I haven't seen any real difference in results with and without acetone. You can use silver brazing flux between coins but, like the acetone, I'm not convinced that it is really needed. Rivet the stack (I'm using an 1/8" copper from the K&N box in my local Ace Hardware store). Place the stack in a gas forge and watch it like a hawk! You do not want it melting in the forge. Keep turning it over to get the most even heat possible. Eventually it will start to sweat, i.e., you'll see something begin to appear between the layers. That's the signal to get it out and hammer it. Copper melts at 1983 F while cupronickel starts down at 2140 - 2260 F, so the copper will be the first to go. Remember the color when it comes out = you'll need that information later.

The stack starts as a cylinder 0.95" across and probably 0.75" tall (=$3.00). In terms of volume, that's 0.53 in^3. If you mash it flat initially, you won't be able to develop much of a pattern. If you don't hit it sufficiently, it might not fuse. Decisions..Decisions. I usually drive it down to about a 1/2" to 3/8" thick or about 22 to 41 % wider than it started (Table 1). It's then over to the drill press to drill a matrix of shallow holes into one face of the stack. The size and depth of the holes is also a balancing act. Deep holes means more complexity in the pattern but a thinner final disk. It all depends on what you intend to use the material for. If it's being used for bolsters on a thin folder, then thin is okay. If you need 3/8" material for bolsters on a non-folder, then you need to preserve as much thickness as you can.

Height *inches*	Diameter *inches*	Increase *percent*
0.500	1.16	22.47
0.375	1.34	41.42
0.250	1.65	73.21
0.125	2.33	144.95

Table 1: Stack sizes

There is no reason to fixate on 12 coins (the $3 stack). If you need more thickness, start with more coins. Of course, the taller the stack, the more likely there is going to be incomplete fusions due to side-slips, so increase stack size gradually as your experience and confidence increases.

Once the stack has been drilled (or chiseled or milled or....), run it back up to temperature (see why you need to remember the color?) and hammer it out until the material is once again reasonably flat.

If you need more thickness, you can (theoretically) stack stacks on stacks and fuse them (something I haven't tried yet) or you can solder stacks to filler material, like brass or copper or other stacks. If you do this, be conscious of the final thickness needed so you don't end up grinding off all the mokume gane to get the handle the size you want.

Quarters appear to be the sweet spot. You can get a wider stack initially by using half-dollars. The problem with that is that the cost doubles but the area grows by only 25%. Making mokume gane from quarters does mean that there will be some unavoidable waste. The stuff does not like to be edge forged, so you'll be dealing with ovals to circles. The material saws easily and a touch of ferric chloride pops the pattern out.

The picture at the bottom of the page will give you an idea why the stuff is addictive and is of a 624-layer random pattern Damacus full-tang blade with mokume gane bolsters and pommel plates flanking water buffalo horn scales.

References

Ferguson, Ian. 2002. Mokume Gane. Krause Publ. 128 pp.

Midgett, Steve.2000. Mokume Gane - A Comprehensive Study. Earthshine Press. 157 pp.