ELEMENTAL FORGE

Random Damascus

By Michael Kemp
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The good ship Damascus docks in a wide berth. For practical purposes Damascus just means a patterned metal.

Crusaders coined the term to describe swords from the city of Damascus which exhibited extraordinary cutting abilities and whose steel had a watery look. Those swords were forged from ingots of "wootz" that came from a series of mines in India and these ingots not only contained high concentrations of carbon (1.5% to 1.7%), but also vanadium and manganese. Today this is referred to as genuine Damascus. Those mines in India were mined out long ago. In recent years the alloy banding that gave genuine Damascus its watery look has been recreated in limited quantities by Alfred Pendray and his followers.

As opposed to genuine Damascus, forge welded steel accounts for the vast majority of Damascus blades being produced today. Forge welding steel can be produced from layered Damascus, cable Damascus, and/or can Damascus.

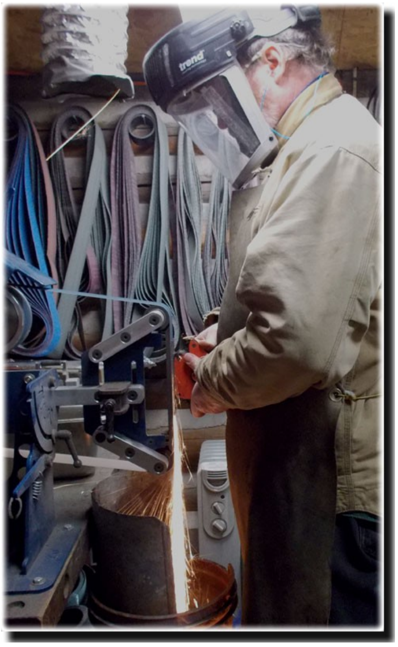
Layered Damascus involves stacking alternating layers of two or more steels which have different resistance to etching then forge welding those layers into a billet. After a blade (or ring or broach...) is made and polished it is etched to reveal the banding of the alternate steel layers.

Cable Damascus is similar to layered Damascus except that you start with steel cable. I've tried cable Damascus a few times and it ain't easy! The individual wires resist packing into a solid billet. The organic cell-like pattern of the finished blade is attributed to decarburization of the individual wires.

Can welded Damascus involves inserting shaped pieces of steel into a metal container and filling the voids with powder of a contrasting steel. Again, the contents are forge welded and the finished product is revealed with an etch. The revealed pattern of can Damascus can be like a line drawing – Daryl Meier created a Bowie for George Bush (41) with American flags in the steel.

Layered Damascus can be twisted, crushed, rolled, cut, re-stacked, and mashed to create an incredible variety of patterns. These can be as bold as a 1970's disco tie, or at high layer counts the pattern can be quite subtle. I love the wandering feather pattern. One of these days I'll get up the gumption to take a stab at that pattern.

In the mean time I'm happy if I can make a good billet of high layer count random Damascus. That's what I did last week – and here's how!



Random Damascus means that the pattern is dependent on the mechanical process of repeatedly drawing and squaring the billet. I started with 1095 and 15N20 steels. To prep the steel I cut 6” pieces and ground off the mill scale.

A welder's magnet works great to hold pieces like this to the grinder without losing too much blood and skin.

I stacked alternating layers of 13 pieces of 15N20 and 14 pieces of 1095. With 1095 on both top and bottom of the billet I have a superstition that the 2nd weld goes better.

I tack welded the corners to keep the layers together, and welded 3 pieces of 1/2” rebar to one end for a handle. I've found a single 1/2” rebar will get ridiculously floppy at welding temps.

While the billet heats up for the initial weld, this is a good time to talk about forge welding.

Regular welding involves some form of melting metal. The two pieces being welded are melted together at the joint – either from their own material for with the aid of wire or welding sticks. When the shared pool of molten metal solidifies you've built a bridge between the two pieces of metal.

Forge welding, by contrast, is a solid state or diffusion process. The layers of my billet have to be in contact with each other at almost the atomic level so that (with the aid of high temperature) atoms from adjoining layers migrate across the boundary and then steel grain structures bridge what was once a boundary – creating a solid block of steel from what started (in this case) as 27 distinct layers.

I only sanded the layers to 100 grit – so that's a far cry from atomic flatness! The trick is to get the steel really hot and plastic and then to gently persuade the layers to lay flat against each other. Some smiths set the billet by gentle hand hammering. I've had luck using a light touch with flat dies on the power hammer. But it's not the hammering that welds the billet. This just gets the layers into near-atomic contact with each other. Then I soaked the billet for 15 minutes at 2150°F to 2175°F. That's where the solid state forge welding magic takes place.

If you know me, you know that I wear a belt and suspenders... so it won't surprise you to learn that I don't trust that the first forge welding will have done a complete job. I gently hammered the billet a second time – not trying to change the shape of the billet, just solidifying it – and I put it in the forge for a second 15 minute soak at welding temperature.

Now I'll trust it's really welded, and it's into the jaws of my wood splitter based forging press to stretch it out – alternating the press's drawing dies with the tire hammer's flat dies to square up the faces of the billet.

Different smiths use different steels, methods, and temperatures – all of which interact to determine the success of their Damascus.

At my skill level – and going for 500 to 700 layer count – I lose about half of the steel I start with. After welding 27 layers and drawing the billet out to 11", I cut it into thirds – then ground the mating surfaces flat – then re-stacked and tack welded it into an 81 layer billet and went for another round.

But it's really not 81 layers. Every time I pull the billet out of the forge into the open air oxygen attacks the steel and forms scale. At these temperatures I'm always fighting NOT to pound the scale into the billet. Luckily most of it flakes off around the power hammer and press dies:

But that's only part of my stock loss. Once I've stretched the billet out long enough to cut and re-stack it, I'm in for my major losses. My billet ends are never square, and often have a bit of delamination – so that's a loss. And then there's my over-aggressive drawing dies. Despite my best efforts to square up the billet with the flat dies on the tire hammer I wind up with divots in the surfaces of the billet. I don't trust that I can just clean out the scale and the uneven surfaces will mate properly for the next weld – so I grind down the mating surfaces to the bottom of the deepest divot.

In this photo you can see the unusable end bits (marked at the left and cut off at the right) and the start of grinding out the divots on two of the three sections.

So what would theoretically be a layer progression of: 27 – 81 – 243 – 729 is probably more like 27 – 75 – 210 – 600? Call it 500. I ground out a lot of divots.

So after 3 rounds of welding/drawing/cutting/stacking and the final weld and drawing out – what started as 6# of steel plates is now 3# of random Damascus. And thankfully, it rings like a bell (a good sign that the billet is solidly welded – but no guarantee against inclusions or small internal flaws). To check the pattern I sanded the final billet down to approx. 600 grit and did a quick etch in ferric chloride.

And here's what the pattern looks like:

It looks like good wood burl – just like I like it. Now all I have to do is make knives out of it <cough><cough>.

I'll be doing more of this. I love the magic of steel, fire, tools, and time.

Keep Well!
Michael Kemp