

MOKUME GANE: STEP BY STEP

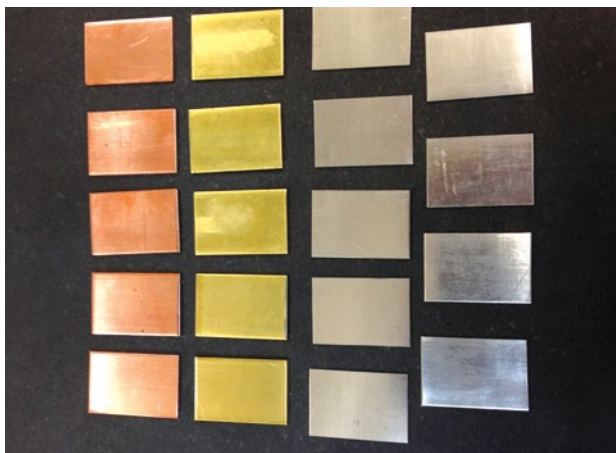
Presented by James Binnion

The Japanese words *moku* (wood) *me* (eye) *gane* (metal) are most often translated as “wood grain metal” and describe a wood-grain pattern created during the lamination of various combinations of precious or nonprecious metal alloys. The lamination process involves stacking very clean metal sheets between heavy steel plates, which are then bound together and fired in an oxygen-free atmosphere to fuse the sheets into a laminate.

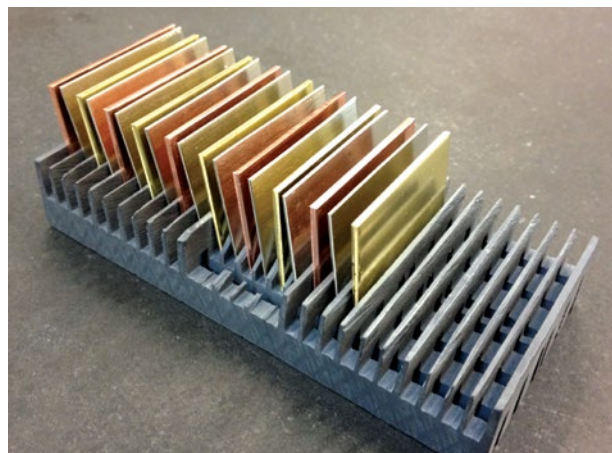
There are various methods for creating patterns in the laminate—some as old as the Japanese technique itself and some achievable only with the use of modern technology. All manipulate or modify the laminate—whether by forging, cutting,

bending, or twisting it—to display the inner layers of a stack. The most common method is horizontal patterning, which typically relies on cutting or punching in a direction perpendicular to the layers of the laminate to develop a design.

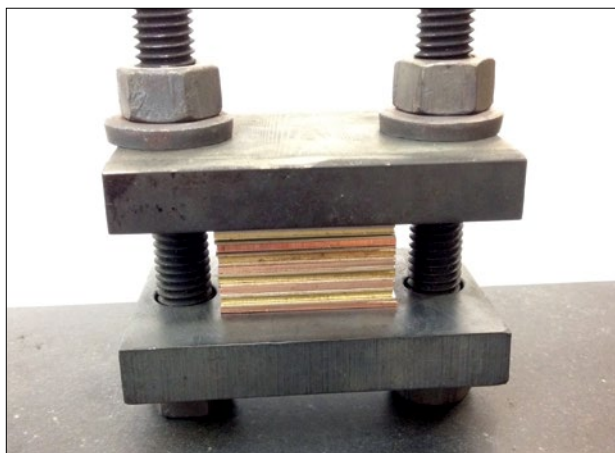
James Binnion characterizes learning to make mokume gane laminates as a difficult technical challenge. But he also notes that whether you make your own laminated stock or buy it from a supplier, it is in the patterning that you can show your signature style. With some practice, the patterns you create are truly limited only by your imagination.



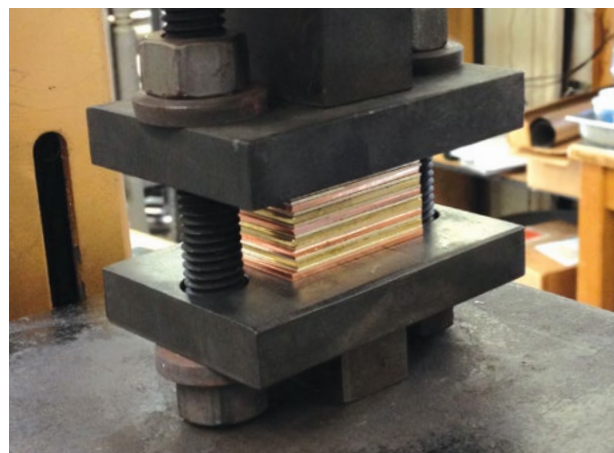
1. These copper, brass, nickel, and silver sheets are 1 by 1.5 inches. The gauge is variable and depends on the line weights desired for the pattern. These sheets are 18 gauge.



2. The metal must be absolutely clean before lamination. These pieces were scrubbed with a wet Scotch-Brite Purple scouring pad to expose bare metal and rinsed in clean water. The water-break test can be used to confirm that the sheets are free from dirt, oxides, and oils: After immersing a sheet in clean water, remove and hold at a 45-degree angle. If the water drains as a solid sheet, the metal is clean of contaminants that might interfere with laminating; if the water beads up or breaks in a line or in blotches, the metal needs additional cleaning. Once the pieces are clean, they can be blow-dried or patted with a clean lint-free paper towel or cloth until they're dry.



3. The clean sheets are stacked into a billet and placed between torque plates. Each mild-steel plate is approximately half an inch thick; half-inch bolts pass through holes and are torqued down (tightened) to provide pressure on the sheets during lamination.



4. The hydraulic press ensures intimate contact between the sheets being laminated. The bolts are further tightened by hand while the billet is in the press.

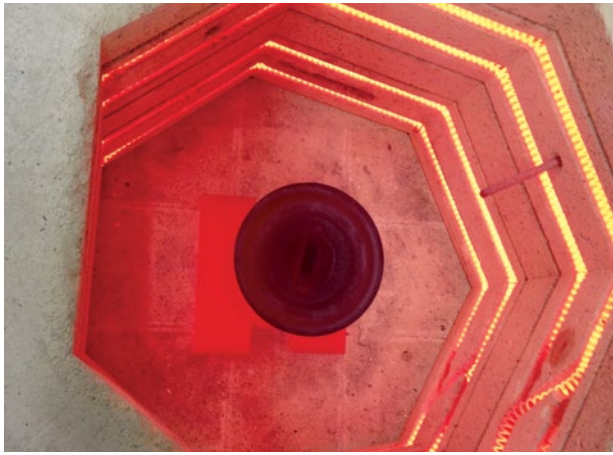


5. The billet is placed in a firing container on a bed of granular charcoal and then covered completely with more charcoal to provide protection from oxygen during the firing.

Precise temperature control is key for the electric kiln. Because the kiln will reach a high temperature of 10°C-38°C (50°F-100°F) below the melting temperature of the alloy with the lowest melting point, it's critical that the kiln be accurate to within 10°C (50°F). Note: Kiln temperatures can reach 982°C (1,800°F), but are typically lower.



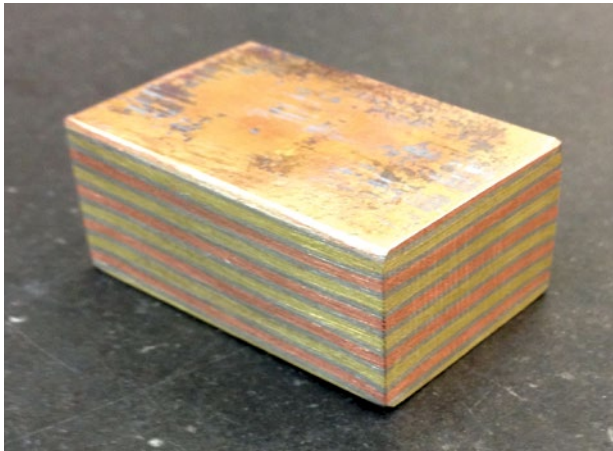
6. When the kiln reaches the appropriate temperature, load the firing container into the kiln and heat the billet for three to twelve hours, maintaining that temperature throughout. The time range for this *soak* is dependent on many variables, including kiln type/power, size of billet/torque plate assembly, and amount of charcoal between the wall of the can and the billet. It must be determined empirically. Note: A shorter time is better, but if it's too short, the metals will not bond.



7. The kiln is still very hot when the firing can is removed. Observe appropriate precautions when working in a hot kiln environment.



8. The billet is removed from the torque plates and forged while hot, using a torch to keep the billet at the appropriate forging temperature. This is the bonded billet after the initial hot forging step.



9. The billet is trimmed to remove any unbonded edge material. Binnion uses a milling machine, but a saw or file will work.



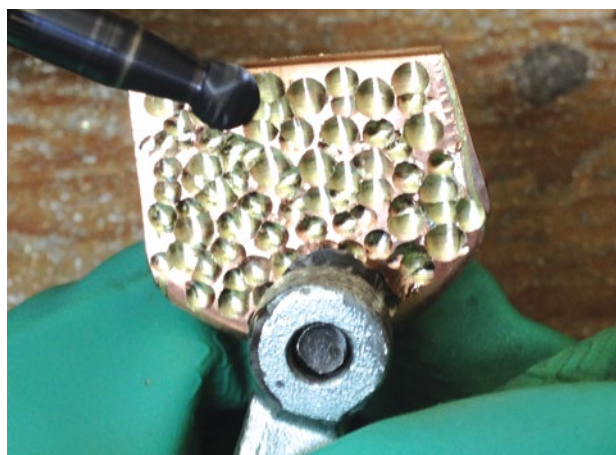
10. Multiple hot and cold forging stages with hammers and presses follow to reduce the thickness of the billet prior to patterning the laminate. Forging the billet properly requires a lot of skill as well as continued attention to the melting points of alloys in the laminate. For example, billets containing silver must be forged at a black heat (not a red glow, so to a maximum of 482°C [900°F]); nickel alloys may delaminate if not forged before being allowed to cool.



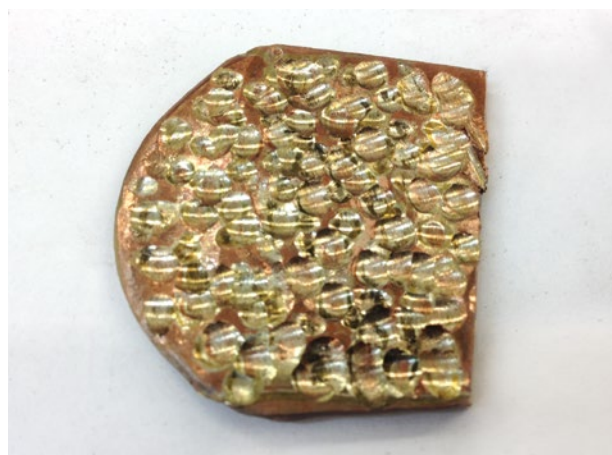
11. This is the laminate in the midst of the forging process. The goal is to reduce the billet by at least 50 percent. A rolling mill that handles thick material could also be used at this stage. Anneal often when rolling down to keep the billet from delaminating.



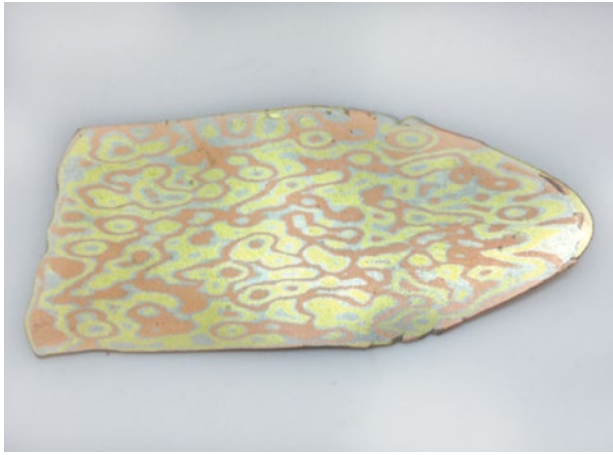
12. The forged billet is cut with a saw to size for patterning.



13. The patterning method shown here is a horizontal one: Binnion uses a high-speed air-turbine grinder to cut down from the front of the laminate with tungsten carbide burs. (The gloves protect his hand from the resulting sharp slivers.) This reveals the layers beneath the surface of the stack; varying the depth results in a variety of color patterns. Burs were used here, but laminate can also be cut with drills, files, punches, chisels, or mills.



14. Here the pattern is beginning to become visible. As each layer is cut, a band of color is exposed.



15. After the laminate is carved, it's flattened by forging and rolling. As the thickness is reduced, the sheet gets larger and the bands of color from each alloy become correspondingly larger as well. Additional design elements can be cut at intermediate stages in the reduction process to vary line widths with the aim of developing a more complex pattern.



16. This mokume gane ring in 18k yellow gold, 14k palladium white gold, 14k red gold, and sterling silver was made using the process outlined here.