Bonding Platinum and Gold for Finished Jewelry

Steven Kretchmer. • Steven Kretchmer Design

There is clear harmony in the marriage of pure white platinum and the lush warmth of gold. However, there are technical difficulties for the jeweler creating their bonds. Platinum is generally alloyed using more than 90% purity with additions of iridium, ruthenium, copper, cobalt, tungsten or other metals. Yellow-gold alloys are made with additions of varying concentrations of copper and silver with small amounts of deoxidizing additives such as zinc or boron.

There are two major groups of bond types for metalwork of all kinds.

1. Mechanical bonds, and
2. Metallurgical bonds.

We are all familiar with many types of mechanical bonds. We understand mechanical bonds quite readily because they are easy to see. A few examples are:

1. Undercut inlays, seen in ancient and some modern arms and armor. A line or a shape is cut into the surface of the piece and the inside perimeter is undercut. When a softer alloy is puzzle-fit and hammered into the shape, it spreads out and locks into the undercut. It can be subsequently abraded flush, or engraved elaborately.
2. Screws.
3. Rivets.
4. Clasps of all kinds.
5. Stitches.
6. Wedges.
7. Linking.
8. Keys.
9. Links.
10. Expansion fitting; and many more.

There are many types of metallurgical bonds. However, our understanding of metallurgical bonds is limited because few jewelers have found the need to develop an understanding of metallurgical principles. It helps a great deal to understand metallurgical bonds when alloys are perceived as solid solutions. Just as sugar in coffee is a liquid solution, so are alloy solutions, but they are solid. Alloys are mixes of pure metals dissolved into each other, except they move slower than liquid, sugared coffee. You can increase the saturation of the sugar in coffee, and at a certain concentration it won't dissolve until the temperature is raised. Raising the temperature forces atoms to move faster and mix deeper past each other. If the hot, sugary coffee temperature drops, the sugar will precipitate back to solid crystals. The size and how the crystals will appear is dependent on the process of cooling. Most metals are like sugar and coffee. That is, not only do they follow all the same principles of behavior, but they also do not mix completely into each other at all temperatures or concentrations. Silver and gold are a very rare exception and alloys dissolve completely into each other at all temperatures and concentrations. On the contrary, platinum and gold do not form many solid solutions at room temperature.

There are many types of metallurgical bonds that when brought up bring to light their differences with mechanical bonds. Some examples of metallurgical bonds are:

1. The weld. There are, of course, many types of

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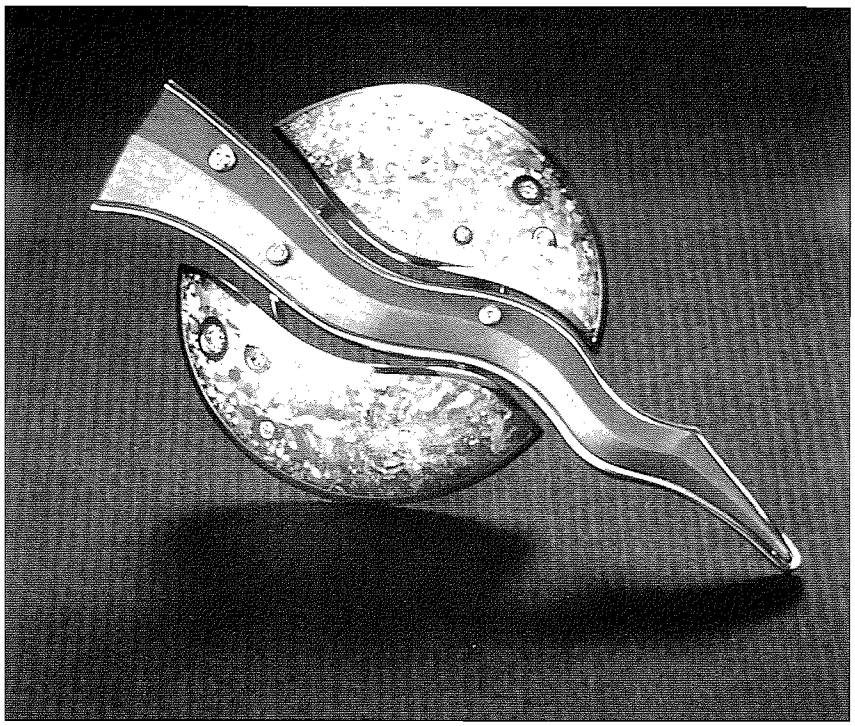
"Moonlight" ring. Kretchmer Tension Setting in special 950 platinum alloy and 24 karat fine gold with 1 carat diamond.

welding techniques, whether by torch, electricity or laser. A weld is essentially achieved by melting the metals together.
2. Soldering or brazing. That is, using a filler material that flows at a lower melting temperature than the metals being bonded. The traditional jeweler is most familiar with this type of metallurgical bond.
3. Galvanic deposition. Electroplating of one metal onto another metal or alloy.
4. Puddling. The depositing of a fluid metal onto the surface or into recesses of a metal of a higher temperature that remains solid.
5. Electrical resistance;
6. Powder metallurgy or sintering.
7. Vapor deposition;
8. Friction;
9. Multi-metal casting;
10. PMCs (precious metal clays);
11. Firing bullets on hot metal (!);
12. Diffusion and many more.

There are two factors that might be a concern in the metallurgical bonding of platinum to gold. The first, as previously mentioned, is that platinum and gold do not form many solid solutions at room temperature. In general, they do not like to mix at all, like oil and water. This makes for limited malleability of most metallurgical bonds between them. This is especially true with diffusion-bonding where the dissimilar alloys are pressed together clean with no filler, and are raised in temperature to accelerate the diffusion between them, forming a metallurgical bond. Diffusion-bonding is based upon the fact



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"Jovan Collision, 1994". Brooch featuring 18K purple gold. 950 platinum with 24K crystal gold inlay. 18K and 20K yellow golds. Diamonds.

that atoms migrate and diffuse like sugar diffuses into water. Platinum diffusion bonded to gold will have an interface of varied concentrations of the alloys and in many zones can be inherently brittle.

The second concern, mostly when brazing, is the coefficients of linear expansion. Gold and platinum expand or contract at varied temperatures as all materials do, but at very different rates:

Platinum: 8.9 micro in/in
Gold: 14.2 micro in/in

There are major factors for achieving a good bond. They are:

1. Relief of all residual stresses;
2. Intimate contact of surfaces;
3. Cleanliness of the interfaces.

Often manufacturers that try to braze platinum to gold claim "my solder cracks," or, "the platinum cracks," or even, "the gold cracks on cooling." This is likely due to residual stresses in the platinum that must be relieved. Stresses are created by working the alloy or even by varied solidification rates within a casting. Any difficulties in soldering gold and stressed platinum will also be compounded by the differing expansion rates of the two metals. Stresses must be relieved by a stress-relief anneal. There are three levels of anneals:

1. Recovery anneal or stress-relieving anneal;
2. Re-crystallization;
3. Grain growth.

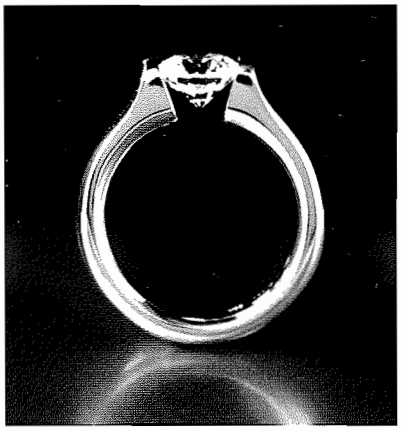
All that is required for bonding is to stress-relieve anneal the platinum alloy so it is possible to braze gold to it without the platinum warping. This can be done best in a controlled furnace at about 1100°F for a half-hour or so. Times vary depending on the alloy or thickness of the piece. When certain manufacturers and designers apply this technique, many of their difficulties with brazing gold to platinum disap-

pear. Some manufacturers stress-relieve the piece after brazing as well.

Fitting the pieces together quite closely is very important and it will help to slightly chamfer or round the edges of the interface to accommodate the fillet of filler alloy. Some designers prefer a white solder, others prefer yellow. If it is white, of course it should match the color of platinum as closely as possible. If it is yellow, it should match the gold component being bonded. There are not yet commercially available solders designed specifically for the brazing of platinum to gold.

Having a clean interface is also very important when brazing gold to platinum. That is, no fingerprints or oil of any kind can be present. Pickle the pieces well to remove any oxides that would inhibit flow through of the filler alloy into the interface, rinse with distilled water and clean with alcohol. Some manufacturers use electro-cleaning and dry by hot air. Air from a compressor might contain contaminants. The flux used to protect the gold during brazing should also be very clean and free from contaminants.

It is wise to consider engineering factors when designing pieces that involve the bonding of platinum to gold. Factors that might seem disadvantageous can always be used to a designer's advantage. For example, gold expands more than platinum per degree increase in temperature. Why not fit a warm ring of gold over a cold ring of platinum and let their temperatures equalize at room temperature, never again being able to be pulled apart? If engineered properly, this mechanical bonding technique of expansion fitting is very effective.



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Flat-top "Omega" Kretchmer Tension Setting in special 950 platinum for 1.5 carat diamond.

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"Jupiter" ring. Kretchmer Tension Setting for 2.5 carat radiant-cut diamond of platinum with 18 karat multi-color "Monkume-gane".

This technique is old, and had been commonly used for fitting bronze bearings onto engine crankshafts. Different shapes could even be expansion fit over others. It is possible to imagine a complex piece of jewelry assembled by expansion fittings alone, completely without solders.

The purity of platinum, its high melting point, and the non-corrosive nature of many of its alloys allows for special bonding techniques. Gold can easily be puddled into recesses and onto unaffected platinum surfaces, so long as contaminates and oxides are kept from the gold, as in inert gases or anti-oxidizing glazes.

Bi-metal casting is an excellent solution for combining gold and platinum. Platinum-iridium, widely used in the United States, can be heated up to very high temperatures without oxidizing at all. We can, therefore, throw molten gold against it and they will bond (bullets on hot metal). Platinum parts can be fabricated or cast, brought to a perfect polish, set in wax (or wax injected onto them), invested, burned out and bonded to gold by casting gold into the flask. Diamonds can even be set in the finished platinum components first. As mentioned, the bond between platinum and gold is not very malleable, so it is a good idea to design "teeth" or mechanical "interlocks" to add strength to the bond. There is no more precise fit between gold and platinum components than by a successful bi-metal casting.

Techniques are the leaves on the tree of principles. Understanding the principles of bonding the alloys of platinum to gold alloys gives us many possibilities for experimentation. Experimentation is the adventure of the artist. The wonderful variations a jeweler can combine with the precious colors of noble platinum and gold are only limited by our imaginations. ◆

Many thanks for the participation of:

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