Understanding Plumb Platinum™ Solders

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Soldering, (as opposed to welding) is using a low temperature material to bond or fill materials in an item.

WHAT DOES "PLUMB" MEAN IN SOLDERS?

When the precious metals content in the solder matches or is superior to the jewelry, we call it plumb. Otherwise we call it "repair" grade solder. Different makers of solder use somewhat different terminology for low karat solders, but plumb always means at least matching the precious metal content between the solder and the jewelry.

As we know, platinum jewelry normally runs from 90% to 95.2% Pt. To understand plumb" platinum solder, I must also talk about gold solders a bit for comparison. When we consider gold jewelry in the United States, we see gold content run from 41.66% (10K) to 75% (18K) with some exceptions, such as the very rare 91.66% (22K) and some imported jewelry that may be as low as 33% gold. You can see that in nearly all instances, we have a lot of alloy to work with in creating solders for gold compared to platinum.

For decades now we have been accustomed to gold solders that run in gold content from 25% to 80% gold. In previous years way back when, we only had gold solders that had a lower content than the jewelry. One example is how jewelers used to mix 1 dwt of silver solder with 1 dwt of 14K scrap. This gave them a 7K yellow solder with a low flow temperature. In more recent times we have been able to use cadmium to reduce the flow temperature of solders. That fairly toxic material allowed high quality solders to be made in "Plumb" grade. Other very low melt elements are used instead of Cadmium. Tin is sometimes used. Indium is a very common element in the solder trade. In fact indium has been used by PMWest, my employer and by my employers father (at the old PMR co. in Buffalo) since the very first days instead of cadmium. For 14K, or even 18K, we have a lot of alloy we can use to get the color, strength and low characteristics we desire.

The gold content in gold solders varies a lot. Unlike jewelry, gold solders may or may not be stamped with the gold content. "Plumb" solders of course are. What we call "repair" solders in gold and platinum, the precious metal content is adjusted solely for either melt and color, or at the wholesale level price. Then the solder is marked with either the intended use like 14ye or stamped with the flow temp like 1100 pt solder. In this paper I will address the previous conventional platinum solders as "Repair" solders and the new solders as "plumb". This is similar to what we are all used to in gold solders.

A FEW RHETORICAL QUESTIONS...

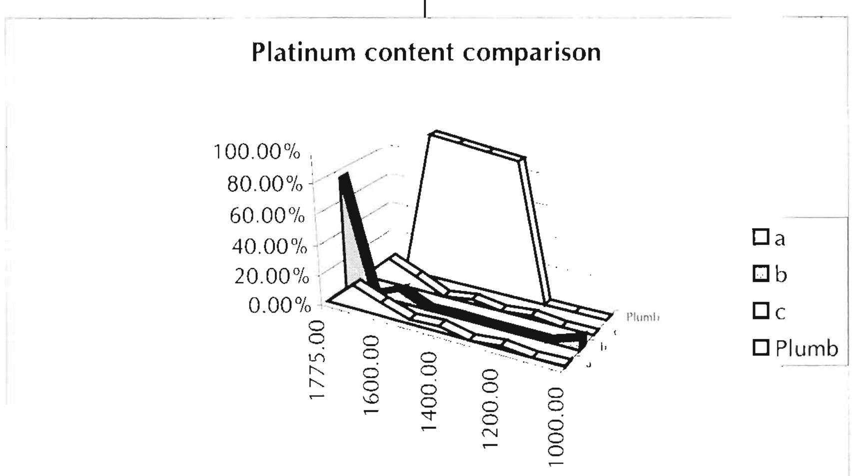
What is really in "silver" solder? Silver of course in varying amounts but lots of silver.

What is really in "lead" solder? Lead of course, even though we use it on copper pipe most often!

What is really in gold solder? Gold, and most often in the same percentage as the rest of the jewelry.

What is really in "Platinum" solders? A different story.

In what should be called "platinum repair" solders, a necessary lack of Platinum causes the addition of substitute metals intended to pull down he flow temp while providing color and strength. All of us in the platinum solder trade use substitute metals for flow and or color. Bench jew-



elers must be very careful about what brand of solder they use so as to avoid problems. One gets accustomed to a particular brand of solder, and any change requires adjustments along the way. All of these shortcomings help the new laser solder machines look good. In addition to keeping the heat close to the work, a laser welded joint matches color perfectly. The cost however is still in excess of $20,000 for each machine. Many jewelers tell me of how they learned to weld rather than solder platinum due to quality concerns.

Lets examine the metals we commonly substitute for platinum in solder.

1. **Nickel**-Remember all the trouble cause by Nickel in white gold? We usually work to keep nickel out of jewelry where it is practical to do so. Europe prefers no nickel at all.
2. **Silver**-This is hardly a metal commonly associated with platinum jewelry, but it provides important properties to conventional platinum solders.
3. **Palladium**-Too high a melt temperature to help much at all, but it is the very common element found in higher temperature solders. In recent months cost has become a big factor with this important element.
4. **Gold**-Wrong color and too high a temperature to solve the flow.

These metals do have shortcomings. Poor color, porosity and some very visible seams just to name a few. This is often fixed with rhodium plating, but that is another unneeded expense, and rhodium will wear off with time, which can disappoint the buying public. Due to the unique nature of platinum, we always had to compromise the platinum content of the solders. Sometimes in the higher temps we find some Platinum but only rarely below 1500C. In these solders we do not find platinum content even closely approaching the content in the jewelry. I must point out that all of the above applies to the solders made by PMWest, just like anyone else making solder for use on platinum. At 1500°C there is typically from 10% to as little as 0% platinum content.

Platinum solder rarely really deserves the title platinum. As shown above we usually name a solder by its main ingredient rather than its use. Ever heard of "copper solder?" Of course not plumbers and electricians use lead solder for that. I do not mean to imply any deception was ever intended. Platinum, as we well know from bench work and casting is a very different animal than gold. Astronomic temperatures cause all kinds of difficulties, many of which are best solved by solutions published by PGI! I refer to all those books from previous platinum days.

In late 1998 after presenting a paper for Platinum Day West, I had a meeting with my boss Keith Weinstein. I wanted to do another paper for PGI. We discussed a few ideas then I brought up a long shot possibility.

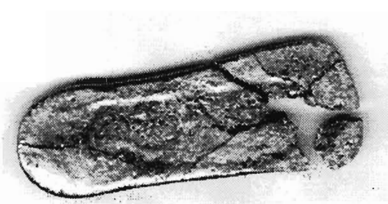
At the time rumor had it that the new "Heat treatable" S+™ platinum developed by Steven Kretchmer melts below 1700°C, perhaps close to 1600°C. –This was the first commercial casting grain with the lower flow temperature. *Really, in common experience there were no platinum alloys with low flow temperatures at all.* Once the fact that this could be done at all was commonly known, many possibilities emerged and will continue to do so.The possibility of using that metal as a solder came straight to mind, but a solder that is too hard creates problems for finishing, and 1600 is not a very low temp for a good Pt solder. But the seed was planted.

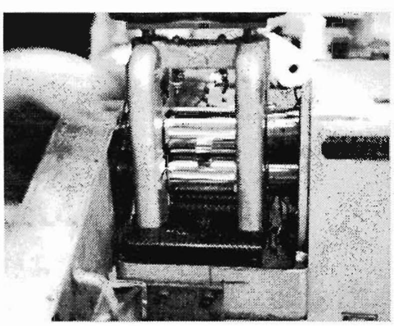
I suggested that if we applied 30 years of solder making knowledge to the principles found in S+ and published JM alloys, we could develop "plumb" platinum solders. After taking a look at our own solder formulas ideas took real shape.

Keith's reaction was predictable. If this was so easy why was it not done before? I reminded Keith that even though solders had been out a long time, S+ was very new . I also realized that very little had been done for decades due to that fact that platinum had been out of common use for so very long. Keith then really hit the books. More detail about the development story can be found in the upcoming Ptday west 1999 book. That paper is titled "Developing Plumb Platinum Solders". Keith found the work done by Johnson Matthey, Steven Kretchmer and papers from PGI to be very helpful. In fact, only personal time constraints kept Steven from working with us on this new product.

My feeling was that for a viable line of products we needed "easy" "medium" and "hard" grades of solders. That means three distinct flow temperatures, all as low as possible. Keith was able to invent one kind of viable alloy that did what we needed. The obvious thing to do was vary the Pt% for flow temp purposes. There were many things to evaluate. We discussed a few formulas. The form the new solder would take would be the familiar sheet, rolled fairly thin and cut into single dwt pieces. One oddity of solder mfg is that we must make the product reasonably attractive. Jewelers expect solders to have a clean almost polished appearance. This despite the fact that the very same jeweler is going to melt the solder one chip at a time. With some sense of what we needed, we called our man at the shop in charge of rolling mill operations.

When creating a new product your best people are critical. Robert Lumabao brings 10 years of shop experience to the task. Keith gave the initial test formulas to Robert, who began with the 95% Pt solder. The picture shows one example of failure. The other shows Robert at his home away from home.





As Robert worked his way through some predictable properties emerged. The higher Pt content material is easier to roll out than the lower. This is consistent with solder manufacturing in gold. The metals we use to lower the flow temperatures of solder can make the ingots very brittle. This is true in most precious metal solders. With time and effort we were able to roll out sheet plumb solder.

We gave the initial test solders to a local trade shop jeweler, who faces a wide variety of assembly, sizing and repair jobs. His reports were extremely encouraging. We then began a wider series of tests, all based on real world circumstances. Many thanks to the local LA jewelers who tested and reported to us.

A month or so later, at Kraftwerks 1999, I set up a soldering bench with some scrap platinum jewelry and the brand new solders. This was a chance to ask the experts who were present at Kraftwerks that day to assess the new solder.

Anyone who wished to try the solder was given the chance. This included myself, despite a near complete lack of bench experience. Oddly enough, I can work with this solder in platinum easier than I can work in gold soldering. Once I got used to the safety goggles, the soldering is simpler. There is no oxidation or flux to be working around. The hot color makes it easy to see when the solder flows. My feeling is that this will allow the less "platinum experienced" jeweler to have an easier time soldering.

Christian Tse was very helpful. He tried the solder at the bench I set up, and helped determine flow temperatures. When I needed pictures of the solder being tested, he graciously invited me to his studio. Once I arrived and set up my camera, he soldered a couple of pieces of bar stock that had been cast. In the end, the joint was strong, and cleaner than the rest of the host material. Unfortunately, the casting was not as nice as we might have hoped. As we examined the polished solder joint under magnification, we saw pinholes all across the surface EXCEPT for the joint itself. The joint color was a naked eye match.

Jurgen was very helpful (of course). He was another of the first to try the new solder at Kraftwerks 99. We sent samples to a variety of designers and jewelers who work in platinum. Those who found the time, and were kind enough to call reported favorably on the solder.

How to use the Solder

With time and testing we established approximate flow temperatures and found where we must be careful with how we use the solders.

As was suspected, this solder requires no flux. The very high purity seems to take care of any problems in the alloy as far as oxidation goes. We found this solder must not be used like one uses gold solder. By that I mean that this solder is fairly viscous, unlike gold easy flow solders. The new platinum solder stays close to the joint.

All reports of discoloration have been heard from jewelers who pick this solder up as a molten ball with a titanium or tungsten pick. This would imply that those metals either alloy into or somehow discolor the solder. All this really means is that you must use some other way to place the solder at the joint. One trick is that red hot platinum is sticky by nature. Flux can disturb the surface finish, so is not suitable for keeping solder in place. With sizing there is no problem as long as you have enough tension in the joint to hold the slice of solder. One important advantage to the new solder is the superior color match at the lower flows. This allows one to melt the solder all the way through a shank without fear of melting the ring shank itself.

The present available formulations are as follows:

Pt-E is 90% Pt. and 10% alloy, and flows in the 1300°C range- Our "easy flow" solder. As the name implies this is our "easy flow" solder that is "plumb" (same content as the intended jewelry) to all the 90%Pt.10% Ir or Ru or whatever. Its color is closest to 90/10 of course.

Pt-M is 92.5% platinum. The way to increase the flow temperature was to increase the platinum. This material flows in the 1400°C range. This is our "medium flow" solder. Its color works with any kind of platinum jewelry, but is only truly "plumb" to 90/10 jewelry.

Pt-H is 95% platinum. The highest flow among the new solders, it flows at 1500°C or a bit less. We call it the "hard flow" solder, despite the fact that its flow temperature is hundreds below the flow of ordinary casting platinum. It is "plumb" or better to all platinum jewelry. An ironic twist to this formula.... It may be a bit whiter than 90/10 jewelry. In certain items this can be an issue.

Easy, Medium, and Hard is one way to look at the solders. Another is to simply go by the Pt content and match whatever you are working on. That is ideal for color, and works fine when you only need one flow to do a repair. This solder is the closest color match simply due to matching the platinum content. . Scientific testing may show that our flow temps are a bit off. The tests we find most valuable are those performed by jewelers at their benches. After all, those are reality based. Scientific tests have huge value, but can be misleading to apply at the bench. Many theoretical advances in metallurgy have not worked as well as indicated by the tests.

The physical strength of this solder is very high. Like any solder the strength depends on the quality of the surfaces and the technique used by the jeweler. Again, our tests were performed on actual jewelry which was "abused" in typical consumer fashion. I suspect that furnace assembly can be accomplished with the easy flow. That would be an advantage for those who stamp and assemble platinum settings for diamonds. I refer to those "peg base" heads we use in wedding sets. One will notice the solder sheets themselves are quite hard and springy. That is because they get so work hardened during manufacture. The solder will not "polish out" leaving a seam. In *rare* instances, like when the newly soldered joint cools very slowly, some "ridging" can be found. Lightly abrading the ridge, then lightly burnishing around and on the joint, followed with normal polishing can easily address this. Another approach is to heat the item to annealing temperature and quench. All of the flows indicated are determined by comparison melts, not scientific analysis. This would be unusual among our large competitors. The equipment that precisely determines true flow temperatures is quite expensive and rare. However, time and again real world testing has proved the validity of new products.

Plumb solder works well on all common platinum alloys. That includes Iridium, ruthenium, palladium, cobalt and copper. A possible exception may be the new lower flow temperature platinum's such as Hoover & Strongs S+™. By the way just like plumb platinum solder, S+™ is a trademark product. Due to the low melt of these casting and fabricating metals, the usual spread between the host platinum and our solder is reduced. By the way, I want to point out that all high temp solders have a potential problem with some platinum alloys-Simply based on the relatively low melt temperature.

Polishing platinum is a renowned challenge. A common frustration with repair platinum solder is the tendency to polish out and leave a seam. Plumb solder more closely matches the rest of the item.

I also want to caution jewelers who size and repair jewelry made with the low flow platinum's. You may be in for a nasty surprise one day. What I fear is the fact that ordinary "platinum" solders that flow well below the melt of HT platinum do not have the best color match, and may very well polish out of heat treated platinum. Yet if one tries to use 1700 solder (a much improved color match) on a platinum alloy that melts at 1600, well we can hope that no delicate ears are present, and one has a mold of the style in work for a recast.

We have not yet developed a plumb platinum solder that flows at 1200 or less. So, oxidation of the cobalt in certain alloys will still be an issue. Except at the joint of course. With some further technical assistance from friends in the trade we will establish precise flow temperatures, and more detailed physical information. However we believe this revolutionary alloy can be used in 75% to 87% platinum solder (below plumb content unfortunately) for far lower flow temperatures, while still maintaining a very favorable color and behavior. The reason we have not yet tested these is that we have been unable to get the lower platinum solders to roll out. This is where we need some help. I ask that those who share our interest in plumb platinum solder, or who can improve the state of the art work with us. In this vein I want to mention that we have a huge commitment to platinum research at PMWest. Our research includes the newest platinum rapid fire investments, room temperature flask casting, and even "diamond in wax" platinum casting. Considering our small size as a company (9 employees) we are stretched a bit thin. We welcome any input on improving this new product. After all we only began only began testing less than 10 months ago

Thanks to MJSA, PGI, and Jurgen for putting on this premier symposium.