Platinum Alloys, Features and Benefits

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In the recent past, PGI has identified several issues relating to the improper use of platinum alloys for specific manufacturing methods. Rings made from soft alloys would scratch rapidly, some would deform and others would dent etc.

The underlying cause of these issues can be addressed by clarifying which alloy is best suited for which function. This paper will address the suitability of individual platinum alloys for different manufacturing methods, ranging from fabrication to casting, die striking to machining.

Comparing hardness, strength and durability the ideal platinum alloy is identified and recommended for the manufacturing method at hand.

Specialty alloys and the use of them in manufacturing will also be addressed

Platinum bale on pendant after six years of wear

These photos demonstrate the durability of platinum. Both pendants have been worn for a period of six years. The platinum pendant shows some metal displacement, but very little wear. The gold pendant shows major damage that will need to be repaired.

Gold bale on pendant after six years of wear

As platinum is gaining popularity for jewelers in the United States and the world, with demand being over 300,000 oz annually just in the U.S. more and more manufacturers are entering into platinum manufacturing. A task facing manufacturers today is how to take advantage of platinum's rise in popularity. the issue to be addressed herein is the manufacturing challenge. There are adjustments to a tried and tested manufacturing technique However, what is also required is a knowledge of platinum alloys available, so that intelligent decisions can be made concerning which alloy to choose and how much impact that alloy will have on a current manufacturing technique.

Thus, I will discuss platinum's general properties, give a brief overview of the manufacturing problems that present themselves when working with platinum, explain the hallmarking standards around the world that impact on the choice of alloy and the alloys used that allow manufacturers to deal with those standards, and then finally I will provide some detail on the alloys used in the United States.

Platinum's Properties

In some aspects such as weight, hardness and thermal conductivity, platinum's differences when compared to other metals are very pronounced and require a change in procedure. But the metal's differences in other aspects such as ductility, strength and malleability, are slight, and little or no compensation in procedure is required.

Certain characteristics of platinum need to be taken into account when designing a piece. 95.2% platinum/4.8% ruthenium, one of the most common alloys, is, along with other platinum alloys, very dense, such that it has a specific gravity of 20.7 g/cm3 (a typical 18Kt gold alloy has a specific gravity of 15.58 g/cm3—25% less than platinum). Thus, much thinner gauges of platinum need to be used in order to achieve the same weight in design as other precious metals. This ability to use less metal for any given piece is further enhanced by the ability of platinum to maintain its structural strength and rigidity in thin sections and cross-sections. A resistance to buckling or shearing leads to design advantages for earring posts, prong settings, and filigree jewelry, to name but a few applications.

Other factors which seriously affect working procedures are platinum's low thermal conductivity, high surface resistance, and high melting point.

Delicate designs often require very careful joining techniques, and while silver and gold spread weld heat extensively and rapidly from the application point, the thermal properties of platinum result in much more localized heating. As a result, it is possible to retain more of a cold-worked structure in a platinum jewelry assembly than would be possible with most other precious metal alloys. Thus, the retained cold-worked structure has a higher elastic stress range and hence greater buckling resistance, compression and tensile strengths.

The cutting or polishing of platinum is not fundamentally different from gold or silver, but due to the metal's high surface resistance, there is a greater chance of clogging or wearing out of cutting or polishing media. Platinum clogs files, saw blades and machine tips. Smearing is worst where the dragging friction is highest, and least when the surface of the tool is presented as a knife-edge. The secret is to choose a just sufficient cut or polish to remove the marks from precious procedures or before a new medium becomes clogged, and to use a good lubricating compound.

Additionally, a high melting point affects casting techniques, as well as brazing and procedures.

Fig. 1 **[chart]** illustrates that with regard to hardness and ductility, platinum behaves very similarly to 18Kt gold, and while the hardnesses on this alloy chart may be a little higher than many gold alloys, they are not so different. When shown in conjunction with ductility readings, it becomes apparent that platinum in most ways behaves little differently to gold.

Hallmarking

Before reviewing the available alloys, it pays to consider the requirements of the market in which we are trying to sell. Therefore, let's examine the platinum hallmarking regulations of the largest platinum jewelry markets of the world.

Japan

Japan's system of hallmarking, although described as voluntary, places responsibility on the public not to buy unmarked jewelry. Items are marked by the Mint of the Finance Ministry and the marking of jewelry has become a custom. The mark consists of the fineness of the metal, the platinum symbol, and the manufacturer's trademark. Japan accepts all levels of fineness from 85% to 100% platinum, but 90% is most popular.

United States

In the United States, manufacturers are responsible for both the fineness and the stamping of the article. The Jeweler's Vigilance Committee's latest advice to the Federal Trade Commission, who have yet to ratify the standards, is that jewelry which is marked indicating it is platinum should have a minimum of 95% platinum element contained. There are further finenesses that are allowed, but once the fineness of platinum falls below 95%, then the platinum group metal alloying element must also be named. For example, a 90% platinum/10% iridium alloy would have to be marked "IRIDPLAT". If the fineness of platinum falls below 75%, then not only the alloying constituent must be marked, but also its fineness, for example, "585 PLAT 365 PALL". The overriding factor is that items must contain a minimum of 505 pure platinum and 95% total platinum group metals to be described as platinum. The platinum group metals are platinum, palladium, rhodium, ruthenium, iridium, and osmium.

Europe

Most of Europe applies strictly by a single 95% platinum standard, with no negative tolerance, while Denmark, Portugal and Italy allow a 0.5% negative tolerance. In the United Kingdom and France, the standard is enforced by an assay office, which assays each piece, destroying those pieces that do not meet the standard. In other countries in Europe, the onus is on the manufacturer to mark the piece and enforcement is a little more relaxed. But in Switzerland hallmarking is strictly monitored by the government.

Alloys Used Around the World

In markets where certain platinum alloys are specified, it is almost always for reasons of familiarity and for meeting hallmarking requirements-rather than for process improvement-as not much can be done to significantly alter platinum's inherent properties, and nothing can be done to replace excellent manufacturing practices.

In Japan, platinum is most usually alloyed with palladium. A common alloy is 90% platinum/10% palladium. Japanese manufacturers have found that it is soft and ductile, and thus minimizes tool wear. However, the alloy is a dull gray color, and very soft, and thus most Japanese manufacturers rhodium-plate their platinum jewelry.

In Europe, a wider range of alloys is used. The preferred platinum alloy is a 95% platinum/5% copper alloy, which is designated as a general purpose alloy. It is not especially hard or ductile, but it is workable enough to be a catch-all alloy for most machining and hand-working processes. However, it is not a gold casting alloy. A 95% platinum/5% cobalt alloy has found great success with European platinum casters. Cobalt assists platinum's fluidity, and thus leads to greater filling of the cast piece. The alloy is also hard enough to make polishing an easier process. It is the most popular European platinum casting alloy. A 95% platinum/5% tungsten alloy has been used by some manufacturers in Europe, but no one has noted an improvement in platinum's properties that would warrant its widespread use. It is used to a limited extent for stamping.

In the United States, two alloys are mainly used. 90% platinum/10% iridium is used by manufacturers in the same way that platinum/copper is used in Europe. The platinum/iridium alloy is a medium-hard alloy, with fairly low ductility, and is thus applicable for most manufacturing processes. When a manufacturer is looking to use a good, machinable alloy, or when he wants to export jewelry to Europe, a nominal 95% platinum/5% ruthenium alloy is ideal. This alloy is toward the hard end of the range, is ductile (for a platinum alloy), and thus helps manufacturers who are using large-scale manufacturing techniques to produce a large number of pieces. Platinum/cobalt is also beginning to generate some interest with U.S. casters.

Cutting and Polishing Platinum

Let's take a closer look at the alloys used in the United States, but from the perspective of the difficulties faced by manufacturers. Platinum is difficult to cut and polish, difficult to cast, and difficult to handwork. We will see how different alloys may be used to overcome these problems.

Parting and finishing are most often a problem when related to mass manufacturing, and one area in which platinum has gained significant interest is in the production of wedding rings. The rings are produced most often from tube, and thus a key element of their production is the cutting of the tube to produce ring blanks. For this operation to be successful, not only must the manufacturer employ sound technique—good lubrication, the correct cutting rate, the correct cutting tool—but he must also have an alloy to cut which is ductile, has a tight grain structure, and high hardness. An examination of the properties of all the alloys available points to 95% platinum/5% ruthenium as a good choice.

Firstly, ruthenium is a grain refiner, so it automatically gives the alloy a tight grain structure. Secondly, the alloy in its wrought state has an annealed hardness of 130 Hv, and it has a steady work-hardening curve, ending at a full hardness of approximately 190 Hv. Coupled with a high ultimate tensile strength, the alloy will retain its structure during machining, but at the same time will not get so hard that machining is not possible. Tight grain structure and high hardness in particular combine to make a platinum/ruthenium alloy easier to polish than other alloys—90% platinum/10% iridium for example is a soft alloy in its wrought state, with low ductility that makes it feel sticky and unmalleable when being machined or polished. The 95% platinum/5% copper alloy used in Europe is a slight improvement, in that it is more resistant to deformation than platinum/iridium, but it is still not as suited as platinum/ruthenium. The 90%

platinum/10% palladium alloy used in Japan is totally unsuitable for cutting and polishing, in that it has low ductility, low hardness, and low ultimate tensile strength. Its unsuitability and yet its widespread use is evidence that manufacturer preference for the alloy is often a matter of habit rather than practicality.

Casting

Platinum's high melting point makes casting an aggressive process. The key elements of any casting alloy are its fluidity, its lack of metal-to-mold reaction, its mechanical properties, and its color.

Of the alloys available, 95% platinum/5% copper forms a copper oxide skin when in a molten state in air, and this reduces the fluidity of the alloy, making the filling of fine section items difficult. It also produces a dull gray coloration on the cast surface. In addition, mainly in thicker section items, metal-to-mold reaction occurs, causing surface roughness. In Japan, an 85% platinum/15% palladium alloy is widely cast, but it absorbs considerable amounts of gas during melting, such that larger pieces are particularly affected by porosity. Often seen cast surface roughness also demonstrates metal-to-mold incompatibility.

As discussed, a 95% platinum/5% ruthenium alloy has good mechanical properties. However, the alloy suffers during casting, due to metal-to-mold incompatibility, producing surface roughness, which is most marked on larger pieces, and fine section items are often difficult to fill, due to ruthenium's affinity for oxygen.

90% platinum/10% iridium does not have good mechanical properties, but it is a suitable casting alloy. Iridium does not form an oxide film when molten, so other than having some difficulty with the high casting temperatures required, fine detail seems to be easily reproduced. Some very slight surface erosion can be seen in large pieces due to metal-to-mold reaction, and again this is due to the high casting temperatures.

Platinum/iridium does have the advantage of being a particularly bright white alloy—more so than platinum/ruthenium—but at 10% iridium it does not conform to European hallmarking standards, and at 5% iridium its mechanical properties, particularly hardness, are too poor to lend it to machining use.

In Europe, a 95% platinum/5% cobalt alloy is the most commonly used for casting. The alloy is beginning to gain in popularity in the United States, and it does seem to be the most suitable alloy for casting of all the alloys available. The mechanical properties are good, with a hardness and tensile strength very similar to platinum/ruthenium, while its lack of oxidation, other than a slight bluing of the metal surface, mean that the alloy has good fluidity, enhancing its ability to fill fine sections. The alloy also produces little or no metal-to-mold reaction, and the blue/gray/white color of the alloy is seen by many jewelers as a preferable color to other platinum alloys.

Handworking

Platinum alloys are often described as difficult to work with for a number of reasons: they are harder than gold alloys, they are less ductile than gold alloys, and so on. However, as you can see from *Fig. 2* **[chart]**, platinum behaves very similarly to gold in many ways. It is knowledge of the techniques required to work with platinum that will help the jeweler be successful. Ultimately, a competent platinumsmith realizes that platinum is simply different from gold, rather than more difficult, and alterations in technique are required. Once those alterations have been made, working with platinum is little different than working with gold.

To help with handworking, and thus avoid problems like sore wrists, the choice of alloy is important. A number of alloys have been investigated, and 90% platinum/10% iridium proves to be the most successful.

For handwork, all 95% platinum alloys are harder to work with, due to their high hardness and high ductility, and require more "pushing" than platinum/iridium. However, if for marketing or marking reasons a 95% alloy must be used, ruthenium and cobalt alloys both have good tensile properties and have gem-friendly color, which make them very suitable, if a little harder to work.

At the 90% level, again, the Japanese use a 90% platinum/10% palladium alloy, and while it is soft and easy to work—it has been described as like working with butter—it is dull gray in color and too soft to stand up to everyday wear and tear. Thus, a vast proportion of the jewelry produced from this alloy is rhodium-plated. 90% platinum/10% iridium is softer than all 95% alloys, but it has the tensile strength and ductility to make it durable enough for jewelry use. The softness of the alloy makes it much easier to work than the 95% alloys. In addition, platinum/iridium is whiter than most other alloys, so it is most suitable for showing diamonds in all their beauty.

Conclusion

It is hoped that this paper gives you a better idea as to the platinum alloy you will want to use for your manufacturing needs .Your choice is depending on your manufacturing, marketing, and marking decisions. While the choice of platinum alloy will help your manufacturing process, it will not solve all your problems.. It will ,however give you a solid base upon which to build a sound manufacturing technique.

Brazing can be successfully achieved if a jeweler remembers: 1) The joint must fit tightly—take the time to make sure it fits perfectly before attempting to braze; and 2) the joint must be heated directly with enough heat to cause fusion. Because platinum is a poor heat conductor, many times a jeweler will think he properly brazed when in reality he has a “cold-braze-joint”, which breaks when hammered or finished. Heat the joint thoroughly.

Platinum has come a long way since its discovery 400 years ago. It is no longer considered "silver of little value." The fact is that platinum has climbed to the top of the noble metals list. Usually only the finest quality jewelry is made from platinum. Today it is more popular than ever. Jewelers and goldsmiths have traditionally shied away from platinum because of its different characteristics. Unfortunately, until recently, detailed information on working with platinum was rare. In the past a jeweler could expect to find his written information dated 1800s or earlier. But all of that is changing.

Platinum is the white noble metal that is fighting its way back into consumers' hearts—and into their wallets. Don't be left out by not offering it as the premier choice in jewelry for your customer.