A Guide to Platinum Alloys

The world of platinum is not one into which you can step without ample information. Pure platinum is very easy to work with—it can be welded or soldered, and takes on a lustrous polish—but unless it's heavily cold-worked, it remains too soft for everyday wear in jewelry. To alleviate this, platinum is typically alloyed with another metal in order to improve its workability.

The resulting platinum alloy is a so-called "purpose alloy," made for a specific function. An alloy such as platinum/ruthenium, for example, is used in machining because it is easy to cut—but it is not preferred for casting because of its poor fluidity. There are many variations among platinum alloys, each with a specific purpose; to choose well, you must understand each alloy's properties and its compatibility with other metals.

The following guide will help you select from the many platinum alloy systems available on the international market. In the United States, the most common alloys are 95 percent platinum with either 5 percent ruthenium or 5 percent cobalt (a combination referred to as 95/5), and 90 percent platinum with 10 percent iridium (or 90/10); all are represented here, as are several not currently used by U.S. manufacturers. Each system is defined in terms of its hardness (on the Vickers scale), density (to determine the proper amount of metal for casting), melting temperatures (liquidus and solidus, the points at which the metal melts and, after melting, re-forms), and some of its common uses.

So take a look, see which ones will best fit your applications, and remember: As more and more jewelers create works in platinum, the best results will come from those who take the time to get to know their alloys.

Platinum/Iridium Systems

Iridium is one of the Platinum Group Metals. When added to platinum in small quantities, iridium will increase platinum's hardness—though in larger amounts, iridium can cause the metal to lose its ductility. Because of this, the ideal composition for a platinum/iridium system has proven to be the 900/100 alloy: 900 parts platinum and 100 parts iridium.

To many jewelers, the 900/100 alloy is a dream come true. Ductile and malleable, it can be welded with the torch, cast, machined, and stamped. As it does not markedly oxidize, no flux or pickle is required. It has a

Vickers hardness of 110, a density of 21.5, and a melting range of 1,800°C liquidus to 1,780°C solidus.

However, while 900/100 is preferred, a platinum content of 950 parts per thousand is required in the U.S. and many foreign countries in order to mark jewelry “Platinum.” To meet this standard, casters in the U.S. have started using platinum 950/iridium 50, which is actually less expensive. This system has a Vickers hardness of about 80, however, which will lead to soft castings - rings will scratch rapidly and lose their shine, for example.

Platinum 950/iridium 50 works best as a fabricating alloy: It is malleable and ductile, and can be made very hard (about 160 Vickers) through cold working. It has a density of 21.4 and a melting range of 1,790°C liquidus to 1,780°C solidus. It is used a great deal in Germany and Japan for safety catches and pins.

Platinum 850/iridium 150 is used extensively in Japan for findings. It has a hardness of 160 Vickers, a density of 21.5, and a melting range of 1,820°C liquidus to 1,800°C solidus.

Typically, alloys with a platinum content below 850 parts per thousand are not used in the U.S. due to stamping regulations. But there are lower purity alloys available that, since regulations vary by country, are commonly used abroad. Platinum 800/iridium 200, for example, is used exclusively in Germany for very fine mesh and chain product. It has a very high Vickers hardness of 200, a density of 21.5, and a melting range of 1,830°C liquidus to 1,815°C solidus.

Platinum/Cobalt Systems

Cobalt is a white metal with reddish tints. Brittle and hard, it melts at 1,490°C and is generally used as an alloying metal for copper, iron, and platinum. Combined with platinum, cobalt acts as a grain refiner and is used solely for casting.

Platinum 950/cobalt 50 is one of the most superior casting alloys on the market today. It is being used in the U.S., Europe, and Hong Kong. Its good flow characteristics make it possible to fill even the finest details in castings. It is important to note, though, that this alloy is slightly ferromagnetic and oxidizes under certain conditions.

The 950/50 alloy has a Vickers hardness of 135 (which can be further hardened, through cold-hammering, to 270), a density of 20.8, and a melting range of 1,770°C liquidus to 1,680°C solidus.

Because platinum/cobalt tends to oxidize in atmosphere, casting with it should be done with atmosphere control or vacuum. For the same reason, while casting the alloy with a torch setup is possible, it is somewhat difficult with any fuel other than hydrogen/oxygen. The same fuel should be used when welding the alloy, which can also be successfully laser-welded.

This oxidation also necessitates additional steps in soldering and sizing. Ring sizing should be done with 1700 or plumb platinum solders, but remember: During the soldering process, platinum/cobalt will oxidize slightly. To remove this oxidation, let it cool down, firecoat with a solution of boric acid and denatured alcohol, and then bring it to a bright orange and pickle. It is important to remember not to firecoat before soldering, since in the high heat the boric acid becomes a contaminant.

Platinum 950/copper/cobalt combines the fluidity of cobalt with the malleability of copper and, unlike platinum 950/cobalt, is non-magnetic. It is a fine casting alloy and has been gaining popularity in the U.S.

Platinum 900, with 3 percent cobalt and 7 percent palladium, is a traditional alloy used exclusively in Japan. This alloy has a Vickers hardness (as cast) of 125, a density of 20.4, and a melting range of 1,740°C liquidus to 1,730°C solidus.

When an even harder casting is called for, the Japanese employ platinum 850 with 5 percent cobalt and 10 percent palladium. This system has a Vickers hardness (as cast) of 150, a density of 19.9, and a melting range of 1,730°C liquidus to 1,710°C solidus.

Platinum/Palladium Systems

In the jewelry industry, palladium is alloyed with platinum mainly to add hardness. Palladium oxidizes when exposed to air, and the oxides take on multiple colorings at about 600°C. The colors will disappear as the oxidation is consumed at higher temperatures, and will not reappear in the finished product.

Palladium systems have some drawbacks. They are all soft, ranging from 60 to 80 Vickers in hardness, and tend to form cavities in the casting.

Jewelry made from platinum/palladium alloys requires extensive burnishing to work-harden the surface and ensure a fine polish. Furthermore, these alloys have a grayish color; in Japan, many products cast with this alloy are subsequently rhodium-plated.

By tradition, platinum 950/palladium is used extensively in Japan, Hong Kong, and Europe for finely detailed castings, despite a hardness of only 60 Vickers. It has a density of 20.6 and a melting range of 1,765°C liquidus to 1,755°C solidus.

Platinum 900/palladium is the favored all-purpose alloy in Japan and Hong Kong. With a Vickers hardness of 80, it is in many ways similar to platinum 950/iridium. It flows smoothly and casts well, and because it does not discolor or oxidize, it can be welded and soldered. It has a melting range of 1,755°C liquidus to 1,740°C solidus, and a density of 19.8.

A platinum 850/palladium 150 alloy is used exclusively for chain making in Japan and Hong Kong. It is a very soft and ductile metal, ideally suited for this purpose.

Other platinum/palladium alloys contain 3 percent to 5 percent copper, which provides good workability and hardness. A ratio of 5 percent copper (platinum 900/palladium 50/copper 50) will raise the Vickers hardness of platinum/palladium alloys to nearly 110. Used exclusively in Asia, where it is referred to as 5:5 (based on the palladium:copper ratio), the alloy does not take on the color of copper and is a general-purpose alloy. However, while its melting point is around 1,740°C, this alloy is difficult to cast in atmosphere and becomes relatively brittle. If it must be cast, it should be done under an inert gas atmosphere or in a vacuum with a casting temperature of about 1,894°C.

Japanese chain makers prefer to use the platinum 850/palladium 100/copper 50 alloy, even though it cracks and becomes brittle when hot-forged. However, of all the palladium systems, this alloy is the easiest to polish.

Platinum/Gold Systems

Because of the wide temperature range observed during solidification, platinum/gold alloy systems require rapid cooling to prevent them from becoming hard and porous. They can also be age hardened: Heat-treating

these alloys for several hours at 400°C and then quenching will raise the Vickers hardness to about 300.

If you are looking for a general-purpose alloy, a platinum 950/gold 50 system will do very well. It has a Vickers hardness of 90 and can be soldered, welded, and forged. It is also a fine casting alloy and, because gold does not oxidize, does not require a special atmosphere. However, as is typical with this alloy system, the casting needs to be quenched immediately to prevent hardening and brittleness.

Another fine all-purpose alloy is platinum 900/gold 100, which has a Vickers hardness of 135 and a density of 21.3. Used for fabrication and casting, it has a melting range of 1,765°C liquidus to 1,710°C solidus and should be cast at about 1,810°C. It is popular in Japan, Europe, and South Africa.

A third platinum/gold alloy, platinum 900/palladium 50/gold 50, is in many ways similar to platinum 900/gold 100 but is somewhat softer. This makes it more suitable for forging and for elongation in fabricating (e.g., die striking).

Platinum 950/Ruthenium

Ruthenium is a fragile and difficult metal to work with because of its compact hexagonal crystal structure. However, when combined with platinum it makes a suitable alloy. Typically, it is made into tubing, then sliced off and machined for wedding rings.

Platinum 950/ruthenium can be difficult to cast because it is not very fluid, but experienced casters using induction-melting techniques can achieve satisfactory results. Torch melting is not recommended, though, since ruthenium oxide fumes are toxic.

Used in fabrication, platinum 950/ruthenium can be welded and soldered. It has a Vickers hardness of 130, which can be increased to 210 Vickers through cold hammering; a density of 20.7; and a melting range of 1,795°C liquidus to 1,780°C solidus. It is widely used in the U. S., Hong Kong, and Europe.

Platinum/Tungsten Systems

Usually used for spring alloys, platinum 950/tungsten 50 is common in Europe and Germany. It has an annealed Vickers hardness of 135, a specific gravity of 21.3, and a melting range of 1,845°C liquidus to 1,830°C solidus. It can be made springy through aging.

In the United Kingdom, platinum 850/tungsten 150 and platinum 900/tungsten 100 are used for findings and other applications for which a very hard alloy is needed. Platinum 850/tungsten 150 has a Vickers hardness of 251 and a density of 19.5. Platinum 900/tungsten 100 has a Vickers hardness of 350 and a specific gravity of 20.3.

Platinum 900/palladium 50/tungsten 50 is most commonly used in Asia. It is an excellent general-purpose system that is easy to weld, solder, and polish. It has a Vickers hardness of 150 and a density of 21.6, and it can be rolled and elongated. It is, however, difficult to melt in the air and must be worked in an inert atmosphere or a vacuum. It melts at 1,860°C, and casting should take place at 1,960°C to 2,060°C under controlled atmospheric conditions.

Specialty Alloys

As mentioned earlier, some alloys can be hardened through aging or heat-treating. One of these systems is platinum 950 with 1.5 percent indium and 3 percent gallium. A heat-treatable alloy, it has a melting range of 1,650°C liquidus to 1,550°C solidus, a hardness of 225, and a density of 19.3. Compared to other alloys, it is hard, springy, and can be cast.

There are other gallium systems available—some alloyed with copper, some with gold, others with indium—but they make up a very small part of the systems available.

Several heat-treatable alloys on the market today are proprietary, and their contents have not been disclosed. Two of these systems start with a Vickers hardness ranging from 135 to 145 and 170 to 200. These alloys can be heat-treated to reach a hardness of 252 and 306. They can be cast, preferably by induction or with a hydrogen/oxygen torch, and have a melting range of 1,640°C liquidus to 1,600°C solidus. Because of their lower melting temperatures, sizing should be done with a 1,500°C solder.

They can be used for fabrication, machining, and casting. They are less difficult to polish than standard platinum alloys because the harder material more readily retains the shine.

Platinum Alloy	Vickers Hardness	Density	Liquidus Temperature	Solidus Temperature	Characteristics
Platinum 900/Iridium	110 HV	21.5	1,800°C	1,780°C	Good all-purpose alloy.
Platinum 950/Iridium	160 HV through cold-working	21.4	1,790°C	1,780°C	Good fabricating alloy.
Platinum 950/Cobalt	135 HV (270 HV with cold-hammering)	20.8	1,770°C	1,680°C	Good flow characteristics, but oxidizes in atmosphere and is slightly ferromagnetic.
Platinum 950/Cobalt/ Copper	119 HV (239 HV with cold-hammering)	20.65	1,760°C	1,750°C	Versatile alloy for casting, forming, and machining operations.
Platinum 950/Palladium	60 HV	20.6	1,765°C	1,755°C	Used for finely detailed castings.
Platinum 900/Palladium	80 HV	19.8	1,755°C	1,740°C	Flows smoothly and casts well. Doesn't discolor or oxidize.
Platinum 900/Gold	135 HV	21.3	1,765°C	1,710°C	Good all-purpose alloy for fabrication, casting.
Platinum 950/ Ruthenium	130 HV (210 HV with cold-hammering)	20.7	1,795°C	1,780°C	Poor fluidity; can be welded and soldered.
Platinum 950/Indium 15/ Gallium 30	225 HV	19.3	1,650°C	1,550°C	A heat-treatable alloy. Can be cast.