Platinum Alloy Applications for Jewelry

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Before World War II Platinum was the metal of choice for many fine jewelry pieces especially engagement and wedding rings. Platinum was also used to enhance the beauty of diamonds and other precious gems. Many of the world's greatest diamonds are set in Platinum, including the famous Star of Africa in the British Royal Scepter, and the beautiful and famous Hope Diamond on display at the Smithsonian Institute in Washington, DC. During World War II, Platinum was classified as a strategic metal and deemed off limits to jewelry manufacturing, thus losing its market share to the newly developed white gold.

Today, Platinum is enjoying its renaissance. In the U.S., Platinum consumption has risen by more than 700% since1990. More jewelers are carrying Platinum jewelry, and consumers are becoming more aware of the most noble of all metals.

Many jewelers are still confused as to the Platinum alloys available, their application and purpose, In this paper I will attempt to clear up some of these issues.

Working with Platinum

As with all precious metals, Platinum in its pure state is very soft. Pure Platinum is very easy to work with, as it can be welded, soldered and takes on a lustrous polish but unless heavily cold-worked, it is too soft for every day wear in jewelry. It must therefor be alloyed with another metal to improve its workability.

The two major reasons for choosing a suitable alloy depend on the purpose and the market it is to be sold. Items made in Japan or Germany may not meet the Standards of the U.S. and other countries.

Japan allows 850, 900, 950 and 1000 parts per 1000 with a small negative tolerance of 0.5%.

There are several countries in Europe that allow only 950 standard without tolerance, there are countries that allow a small negative tolerance within this 950 standard and there are countries that count Iridium as Platinum..

Platinum Alloys in Japan

5% Copper	Pt950/Cu	Melting Range 1725° C 1745° C	Hardness 120	Density g/cm3 20.0	General purpose Medium Hard Can be cast
3% Cobalt 7% Palladium	Pt900/Co/Pd	1730° C 1740° C	125 as cast	20.4	Hard Casting
5% Cobalt 10% Palladium	Pt850/Pd/Co	1710° C 1730° C	150 as cast	19.4	Harder Casting
5% Iridium 10% Iridium 15% Iridium	Pt950/Ir Pt900/Ir Pt850/Ir	1780-1790° C 1780-1790° C 1780-1790° C	80 110 160	21.4 21.5 21.5	General purpose Catches, Pins Springs, Watches
5% Palladium 10% Palladium 15% Palladium	Pt950/Pd Pt900/Pd Pt850/Pd	1755-1765° C 1740-1755° C 1730-1750° C	60, 68 as cast 80, 72 as cast 90, 64 as cast	20.6 19.8 19.1	Casting, delicate General purpose Chain making

European Countries with No Negative Tolerances

- **Austria**
- **Finland**
- **Ireland**
- **United Kingdom**
- **Sweden**
- **Switzerland**
- **Norway**

European Countries Allowing A Small Negative Tolerance

- **Denmark**
- **Portugal**
- **Italy**

European Countries Counting Iridium as Platinum

- **Belgium**
- **France**
- **Italy**
- **Greece**
- **Netherlands**
- **Spain**

Platinum Alloys Allowed in Germany

- **Pt 999**
- **Pt 960/Cu**
- **Pt 950/Pd**
- **Pt 900/Ir**
- **Pt 950/In/Ga**
- **Pt 950/W**
- **Pt 950/Co**
- **Pt950/Ru**
- **Pt 800/Ir**

These countries are the ones we are referring to when we discuss Europe. Since Germany allows different alloys, it is listed separately from Europe. With the unification of Europe in the next few years these things will most likely change and brought to a uniform standard. The following charts represent things as they are today. Countries adopting the Convention of the Control & Marketing of Articles of Precious Metals of 1972 requiring a single 950 per 1000 Standard without tolerance.

Countries that have a 950 standard and allow small negative tolerances.

Countries that count Iridium the same as Platinum within the 950 Standard.

In order to stamp an item "Platinum" in the United States 950 parts per thousand must be Platinum. In alloying, the minimum amount of Platinum is 500 parts per 1000, and the entire mix must be comprised of 950 parts per thousand Platinum Group Metals or PGM's. While some countries allow for a small negative tolerance where solders are being used, in America that tolerance is zero.

THE PLATINUM ALLOYS

Platinum alloys are also called purpose alloys. That means they are made for a specific function. The alloy used for tubing and machining is most likely different than the alloy preferred for casting, etc. Alloys designed for heat treatment are usually tertiary systems.

The most common alloys in the United States are 95% Platinum with 5% Ruthenium or 5% Cobalt,

and 90% Platinum with 10% Iridium.

1. PLATINUM / IRIDIUM SYSTEMS

Iridium is one of the PGM's. It has a face centered cubic structure and when added to Platinum in small quantities it will effect its hardness. The ideal composition for a Pt/Ir system has been the 900/100 alloy. It was called Irido-Platinum in the 20s and is to this day a very important alloy.

P/Ir 900/100 has been the "workhorse" of alloys in the U.S. It is a very good alloy, representing 100% PGM of which 900 is Platinum. It is also used in Germany and Japan.

To most jewelers, this alloy is a dream come true. It can be welded with the torch, it can be cast, machined and stamped. As it does not markedly oxidize no flux or pickle is required. It is ductile and malleable and an overall great alloy. 900/100 Platinum / Iridium has a Vickers hardness of 110, a density of 21.5 and a melting range Liquidus/Solidus of 1800°C-1780°C.

Pt/Ir 950/50

In recent month, casters in the U.S. trying to comply with the world standard of 950/1000 Platinum are using Pt/Ir 950. This system has a Vickers hardness of about 80, and that can lead to castings that are quite soft. As a fabricating alloy, however, 95/5 Pt/Ir can be made reasonably hard through cold-working. It is being used in Germany and Japan for safely catches and pins.

Pt/Ir 850/150

This is an alloy that is used extensively in Japan for findings and such. It has a hardness of 160 Vickers and a density of 21.5, the melting range is from 1820°C Liquidus - 1800°C Solidus.

Pt/Ir 800/200

This system is used exclusively in Germany. It has a very high Vickers hardness of 200, and a density of 21.5. It is used for very fine mesh and chain product.

2. PLATINUM / COBALT SYSTEMS

Cobalt is a white metal with reddish tints. It is brittle and hard and melts at 1490°C. It is generally used as an alloying metal for Copper, Iron, and Platinum.

Pt/Co 950/50

When it comes to casting Platinum, the most superior casting alloy on the market today is Pt/Co 950. Platinum Cobalt is being used in the U.S., Germany, Europe and Hong Kong.

Pt/Co 950 Pt/Co 955 in Europe

This system has a Vickers harness of 135, and can be hardened through cold hammering to 270 V, and has a density of 20.8. It is slightly ferro magnetic. Casting should be done with atmosphere control or vacuum. Casting Pt/Co with a torch set-up is somewhat difficult with any other fuel than hydrogen/oxygen. It has a melting range of 1770°C-1680°C. Between 700 - 800°C it undergoes an order-disorder transition. Pt/Co can be pickled at room temperature in Aqua Regia.

The very good flow characteristics Pt/Co has make it possible to fill even the finest detail.

When the castings need additional work involving soldering, Platinum Cobalt can easily be done. Ring sizing should be done with 1700 Pt solder. During the soldering process Pt/Co will oxidize slightly. Let it cool down and fire-coat with a solution of Boric acid and denatured alcohol. Then bring it to a bright orange and pickle. This removes the oxidation. It is important to remember NOT to fire-coat before the soldering, as in the high heat the boric acid becomes a contaminant.

Pt/Co cannot easily be welded

FTC Regulations for Quality-marking of Platinum

Effective immediately, the FTC Platinum Guide for marking jewelry made wholly or in part of Platinum provides that items consisting of:

950 parts or more per thousand of pure Platinum can be marked "Platinum" without the use of any qualifying statements;

850 to 950 parts per thousand can be marked in accordance with international standards of "950 Plat."or "950 Pt."; or "900 Plat." or "900 Pt."; "850 Plat." or "850 Pt." (the revised guide permits the use of a two or four letter abbreviation for Platinum);

500 parts per thousand of pure Platinum and at least 950 parts per thousand Platinum group metals can be marked with the part per thousand of pure Platinum, followed by the parts per thousand of each Platinum group metal example: "600Plat350Irid" or "600Pt350Ir";

less than 500 parts per thousand pure Platinum cannot be marked with the word Platinum or any abbreviation thereof.

using the torch. Welding is possible using the hydrogen torch or a laser.

Often countries that have no negative tolerance for their alloys, make up for the fact that solders are not plumb, by adding a bit more Platinum to their alloys. Thus you see Pt 952 or Pt 955 alloys.

Pt/Co/Cu 952
This is a recently developed alloy by Engelhard-CLAL. It combines the fluidity of cobalt with the malleability of copper and is non-magnetic. It is a fine casting alloy and has been gaining popularity in the U.S. It has a density of 20.1, a melting range from 1780°C-1750°C. The Vickers hardness is 120 and can be increased to 240 by cold hammering.

Other Pt/Co Systems.

Pt 900/3%Co/7%Pd
Is used in Japan when a hard casting is desired. The alloy has a density of 20.4 and a Vickers hardness as cast of 125.

To make even harder castings the Japanese employ a Pt850/5%Co/10%Pd alloy. This system has a density of 19.9, a as cast Vickers hardness of 150.

3. PLATINUM / PALLADIUM SYSTEMS

While there is palladium jewelry and findings being made, the main use for palladium in the jewelry industry is as an alloy with Platinum. Adding palladium to Platinum will add some hardness. Palladium oxidizes in the air and the oxides will take on multiple coloring at about 600°C. They do however decompose as the temperature is raised and the oxygen is consumed as the palladium reforms.

Pt/Pd 950
Used extensively in Japan, Hong Kong and Europe, this alloy is preferred for fine detailed castings. As are all palladium alloys, it is very soft and has a Vickers hardness of only 60. The melting range is from 1765°C Liquidus - 1755°C Solidus.

Pt/Pd 900
This Is the favorite all-purpose alloy in Japan and Hong Kong. With a hardness of 80 it is in many ways similar to Pt/Ir 950. It can be cast, welded, soldered and is the most widely used alloy system in Asia. Because of its grayish color, many Japanese products are rhodium plated. Because of its softness, Pt/Pd products require extensive burnishing to work-harden the surface. This will insure a fine polish.
It melts a about 1755°C and should be cast at 1850°C. It will flow smoothly and casts well. It tends to form cavities in the casting.
The metal can easily be deformed by forging in a red hot state. It does not discolor or oxidize. It can be welded and soldered.

Pt900/Pd50/Cu50
Pt900/Pd70/Cu30
Pt850/Pd100/Cu50
Alloys containing ratios of 3-5% Cu provide good workability and hardness.
At 5% Cu the hardness of this alloy is near 110. It does not take on the color of copper and is a general purpose alloy. It is used in Asia. 5% Cu/Pd alloy is called 5:5 and the 3%Cu/Pd alloy is referred to as 7:3.
Even though its melting point is around 1740°C it 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 1894°C.

The Pt850/Pd100/Cu50 alloy is preferred in Japan to make chains. The alloy cracks and becomes brittle when hot-forged. It is important to hammer it after the redness has disappeared. Of all the Palladium Systems, this alloy is the easiest to polish.

Pt850/Pd150
Used exclusively for chain making in Japan and Hong Kong. A very soft and ductile metall ideal for this purpose.

4. PLATINUM GOLD SYSTEMS

Platinum Gold alloy systems, because of the wide temperature range observed during Solidification, require a rapid cooling, or they become hard and porous. One feature of these alloys is the fact that they can be age hardened. Heat treat these alloys for several hours at 400°C and then quench will raise the Vickers hardness to about 300.

Pt/950/Au50
When you are looking for a general purpose alloy, this system will do very well. It has a Vickers hardness of 90, can be soldered, welded and forged. It is also a fine casting alloy and does not require a special atmosphere for casting. The casting needs to be quenched immediately to prevent hardening and brittleness.

Pt900/Au100
This alloy has a Vickers hardness of 135, and is a very fine all purpose alloy. Used for fabrication and casting, it has a melting temperature range from 1755°C to 1710°C and should be cast at about 1810°C. The alloy is popular in Japan, Europe and South Africa. The specific gravity is 21.3.

Pt900/Pd50/Au50 is in many ways similar to the Au100 version, but is somewhat softer

5. OTHER PLATINUM ALLOY SYSTEMS

Pt/Ru 950

Ruthenium itself is a fragile and difficult metal to work with. It has a compact hexagonal crystal structure. When combined with Platinum it makes a suitable alloy Pt/Ru is usually made into tubing, then sliced off and machined for wedding rings. It can be cast, and some manufacturers are doing just that. It is however a difficult alloy to cast. Experienced casters using induction melting techniques can achieve satisfactory results with this alloy. Torch melting is not recommended. Ruthenium oxide fumes are toxic.

For fabricating Pt/Ru has some of the same properties as does Pt/Ir. Pt/Ru has a Vickers hardness of 130. When it is cold hammered, the hardness increases to 210 Vickers. The system has a melting range from1795°C - 1780°C. It is widely used in the U.S., Hong Kong and Europe.

Pt/W 950

Usually used for spring alloy, this system is used in Europe and Germany.

Melting range is 1845°C - 1830°C. Annealed Vickers hardness is 135 It can be made springy through aging. The specific gravity is 21.3.

Pt850/W150
Pt900/W100

Used in the UK these systems are used for findings and applications where a very hard alloy is needed. Pt850/W150 has a Vickers hardness of 251 and a specific gravity of 19.5

Pt900/W100 has a Vickers hardness of 350 and a specific gravity of 20.3

Pt900/Pd50/W50

Among the PtW alloys this is the most commonly used in Asia. It offers excellent general purpose ability, is easy to weld, solder and polish. It has a Vickers hardness of 150 and can be rolled and elongated without any problems. It is difficult to melt in the air and has to be worked in an inert atmosphere or a vacuum Melting temp is at 1860°C and casting should take place at 1960°-2060°C under controlled atmospheric conditions.

Specialty Alloys

As I mentioned earlier, some of the alloys can be aged or heat treated to change the hardness. In reality, these alloys have a behavior more typical to tool steel than precious metal alloys.

A typical 95/5 heat treatable alloy, annealed and quenched at 1100°C will have a hardness of 185. Aged at 700°C and slowly cooled, a harness of 350 Vickers is achieved, resulting in better machinability, create spring properties, and allows for more wear resistance at the consumer level. Several alloys fall into this category, among them the Pt/Au and Pt/W systems mentioned previously.

The first of these ternate alloys was created in Germany in 1987, improved in 1988. In the U.S. a new version of this alloy was introduced in 1998.

There are several heat treatable alloys on the market today that are proprietary in nature and the contents are not disclosed.

Plat / S+1
Plat / S+2

One of these systems is Plat/S+1 and 2. With a Vickers hardness from 135-145 and 170-200 respectively, these alloys can be heat treated and reach a hardness of 252 for +1 and 306 for +2.

These alloys can be cast, preferably by induction or with a hydrogen/oxygen torch. The melting range is 1600°C-1640°C. Because of the lower melting temp of these alloys, sizing should be done with maximum 1500°C solder.

S+ alloys can be used for fabrication as well as machining and casting. It is less difficult to polish these alloys.

Pt950/In1.5%/Ga3%

This system is a heat treatable alloy, melting range from 1550°C-1650°C. It is hard, springy and can be cast.

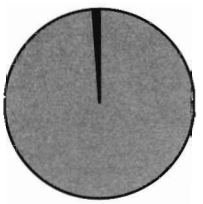
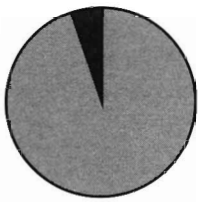
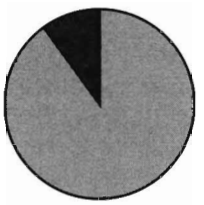
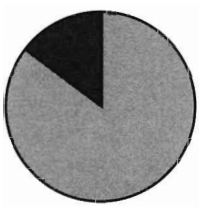
There are other Gallium systems available , some alloy with Copper, some with Gold, others with Indium. These alloys make up a very small part of the systems available and are proprietary and specialized.

I have attempted to cover most alloys available in this paper, describing their uses and applications. New alloys are constantly being researched and developed, and the research to find the ideal system is continuing.

As Platinum jewelry continues to gain market share, nearly every jeweler will have contact with this most precious metal. Education and information about Platinum is good business. Product knowledge is vital. As we are approaching the new millennium and as Platinum increases in popularity, every jeweler will sooner or later have a chance to work with this exciting metal.

COMMON QUALITY MARKS

In the platinum world, 1000 parts equals 100% platinum.
All alloys are derived from these 1000 parts.

Percentages	Common Quality Marks	Alloy Composition
100% or 99% Platinum* 	Platinum Plat Pt Pt1000 Pt999	999 parts per thousand platinum and 1 part other metal **999 + 1 = 1000 parts**
95% Platinum 	Platinum Plat 950Pt 950Plat Pt950	950 parts per thousand platinum and 50 parts other metals **950 + 50 = 1000 parts**
90% Platinum 	900Pt 900Plat Pt900 IRIDPLAT 10%IridPlatinum	900 parts per thousand platinum and 100 parts other metals IRIDPLAT is 900 parts platinum and 100 parts iridium **900 + 100 = 1000 parts**
85% Platinum* 	850Pt 850Plat Pt850	850 parts per thousand platinum and 150 parts other metals **850 + 150 = 1000 parts**

* alloys usually found and manufactured in the Japanese market and may be seen as imports in the U.S. market.