Recent Innovations in Platinum Manufacturing

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Since 1993, platinum consumption for American-manufactured jewelry has increased more than 300%. With this substantial climb in platinum jewelry demand, U.S. manufacturers have had to find ways to reduce rejects, increase efficiency and lower the cost of manufacturing platinum jewelry. Throughout this period, new, platinum-specific manufacturing products, materials and supplies have become increasingly available to the American jewelry manufacturer. For the sake of this article, I will follow the jewelry manufacturing process in its standard sequence of procedures, from casting to finishing, to show the products that are now available for U. S. platinum jewelry producers.

Platinum Casting Investment Powder

One of the most critical elements in jewelry casting is the investment powder used to produce a mold for molten metal. This investment is even more critical for the casting of platinum products. Due to platinum's high melting and flask temperatures, an investment powder that can withstand sustained furnace temperatures up to 1800°F and molten metal temperatures in excess of 3250°F is necessary.

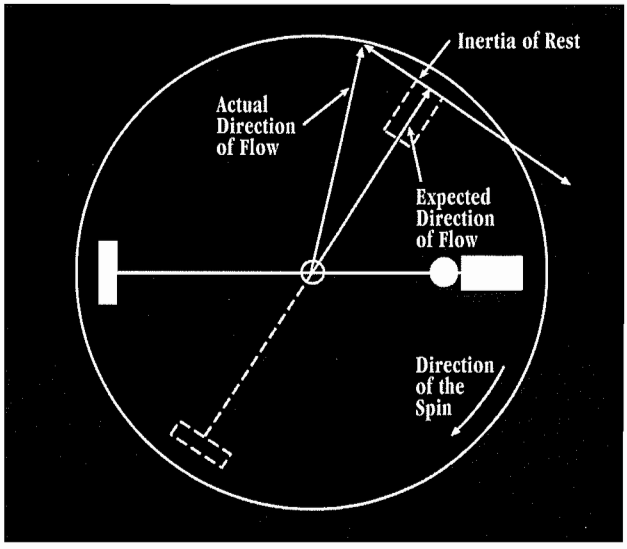
While platinum casting investment powders were available in the U. S. prior to 1993, these powders were developed for the dental industry and do not hold up to mass production techniques. The dental investment powders are not sufficient to produce fine, as-cast surfaces and are subject to breakdown during burnout and casting procedures. Although these investments are phosphate bonded, they do not produce a shell that is as hard and durable during elevated temperatures as phosphoric acid-bonded investments. Consider platinum's density and the centrifugal force required to inject the molten metal into the heated mold when choosing an investment powder.

Phosphoric acid-bonded investment powders that have superior thermal and as-cast surface qualities are being imported to the U. S. from Japan. It must be noted that phosphoric acid-bonded investments require long setup times (from four to 12 hours). This delay can be offset by a quicker ramp-to-flask casting temperature (five hours). If the investment procedures are scheduled properly, a manufacturer can invest in one afternoon and cast the next day.

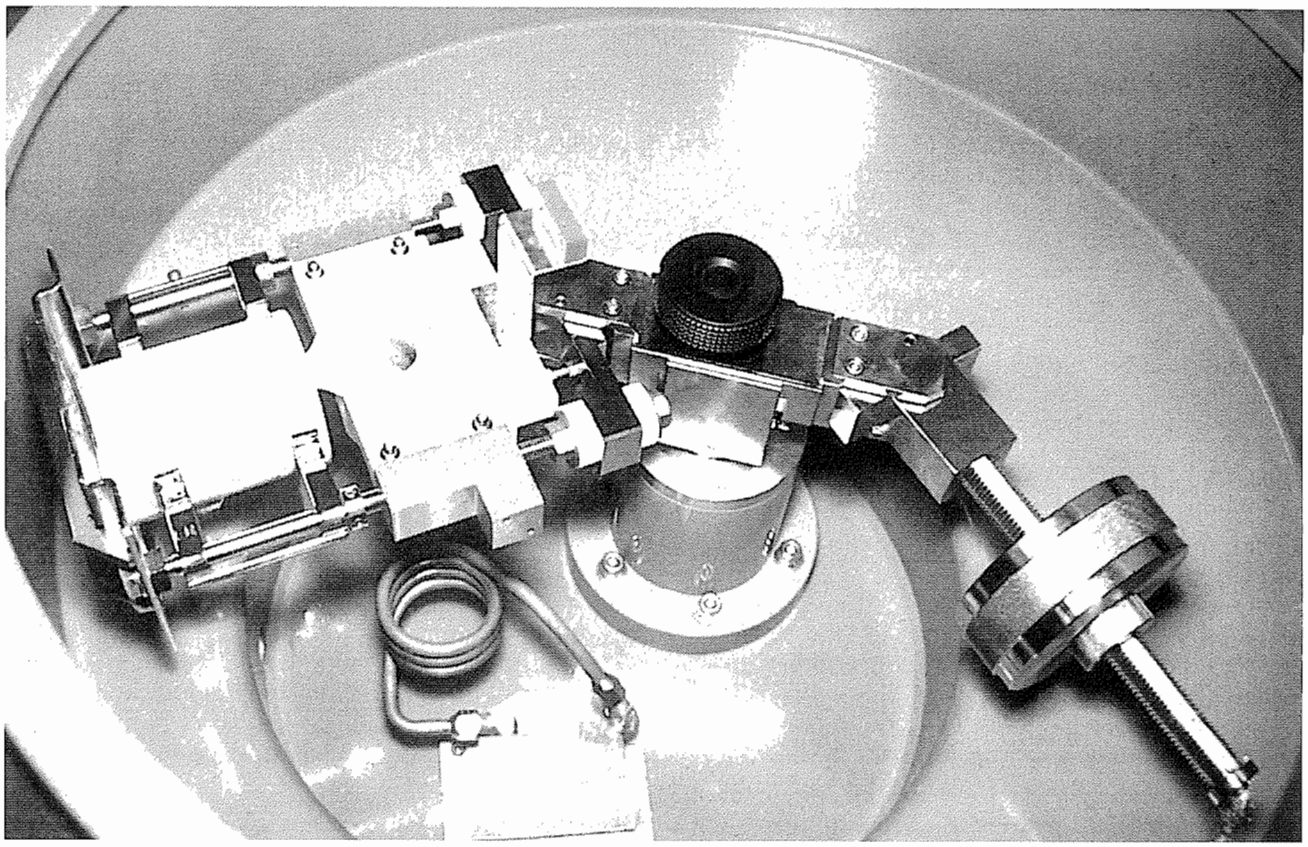
Casting Machines

It has been a common misconception that vertical centrifugal casting machines were necessary when casting plátinum when using a torch for melting. This misconception is easily dispelled by using a small horizontal centrifugal machine that is made for gold or silver casting. The crucible used must be for melting platinum and crucible adapters to fit most horizontal casting machines are readily available for the Wesgo™ Type A and Type D platinum crucibles from most jewelry supply companies.

The use of a standard horizontal centrifugal casting machine is applicable in combination with oxy-hydrogen gas-fired torches. However, induction melting is the recommended method of melting platinum. Induction melting is favored over torch melting due to platinum's propensity to absorb gases such as hydrogen and elements such as carbon, phosphorous or silicon. The use of gases such as



Double-broken centrifuge arm design casting theory.

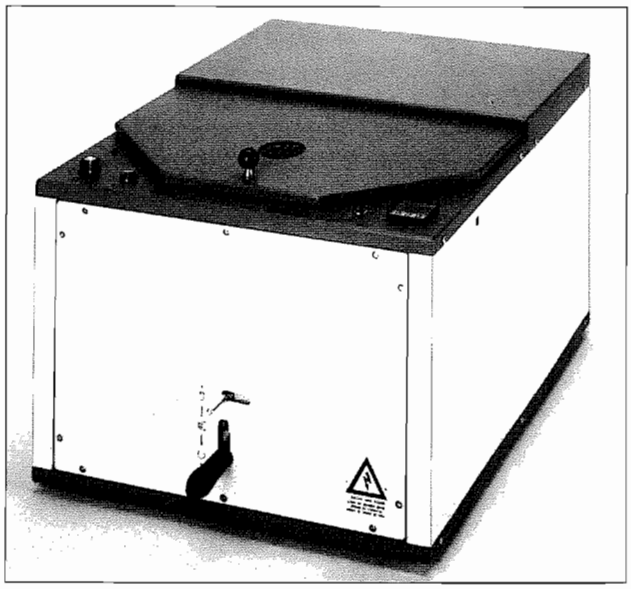


Double broken arm centrifugal casting machine recommended for casting platinum.

acetylene, hydrogen, natural gas or propane can produce an abundance of carbon and hydrogen in the as-cast platinum product, producing gas- or micro-porosity.

In the process of torch melting, there is a chance of overheating the crucible with the flame. If this occurs the molten platinum can absorb silicon that is present in the crucible. In induction melting, the crucible is not heated until the molten platinum transfers its heat to the crucible, therefore minimizing the possibility of cross contamination from silicon absorption, which causes subsequent cracking when cold working the cast platinum product.

While there are many induction casting machines available from Asia and Europe, these machines are quite costly due to currency exchange, shipping and handling charges. There are now at least three American-made induction casting machines currently available for less than $30,000.00. Most induction casting machines have a



Bench top induction casting unit.

150g to 300g capacity, but this capacity mainly reflects the crucible size, not electrical output. If a rapid melt rate is desired, one should opt for a 7.5kw to 10kw output. Anything less than 7.5kw will result in long melting times in excess of two minutes or more.

Of special interest are the new bench-top induction casting units. Although these units are Asian or European made, they cost around $11,000.00 and weigh about 75 pounds.

It was once believed that by casting large trees of platinum jewelry items one could increase the production rate per flask. But there is far more scrap weight than usable product when casting large trees. It has been found that by reducing the size of the total cast weight (including sprues and button) and maintaining this weight at or below seven ounces, rejects will be reduced and product yield to scrap ratios will improve dramatically.

American-made induction platinum casting machines were not available in 1994. As you can see, this is a very recent innovation. These machines can now provide the American platinum manufacturing community with a cost-effective advanced technology.

Zircon Oxide Paint

Whether one is using a torch or an induction casting machine, coating the platinum crucibles with a zircon oxide (ZrO) paint is recommended. Not only will the ZrO paint minimize the possibility of cross contamination of platinum with silicon, by acting as a parting agent it will also promote longer platinum crucible life.

It is best to apply the ZrO paint to a clean, fresh crucible, using an airbrush as an applicator. If too thick a coat is placed on the crucible (by using a paintbrush, for example), the paint will have a tendency to crack and flake off the crucible surface. This cracking is due to ZrO's low thermal shock resistance and it is also the reason that ZrO crucibles are not readily available for casting platinum. By spraying a fine, thin coat on the clean surface of the platinum crucible, one can avoid this cracking or flaking problem.

Graphite Paints

If you have already cast platinum jewelry items, you may have noted that the casting flask will start to flake during the cooling process after casting. These flakes of iron or steel appear to be "fleas" jumping off of the outside wall of the flask during cooling. This flaking is caused by oxidation and contraction of the flask during cooling.

These flakes can cause cross contamination problems in the event that a ferrous flake falls into the flask and comes into contact with a hot platinum button. You may not stop the contraction, but you can minimize the oxidation factor by coating the outside of the flask with graphite paint. This graphite coating will restrict the exposure of oxygen to the heated surface of the flask and reduce the flaking.

Finishing Platinum Jewelry

Besides the casting of platinum, finishing or polishing a platinum jewelry item can be the most problematic process in platinum manufacturing. *(Note: Finishing implies a surface treatment that alters the outward appearance of an as-cast jewelry item, e.g., matte or brush finish, florentine, hammered, etc. Polishing implies a mirror-like luster on the surface of a jewelry item.)*

Due to platinum's density and resistance to scratching, the finishing or polishing process differs greatly from gold or silver. This difference is apparent by the amount of time and the additional steps required to achieve a finish comparable to the other precious metals used in jewelry manufacturing. The finishing or polishing process from start to finish can take three times longer for platinum.

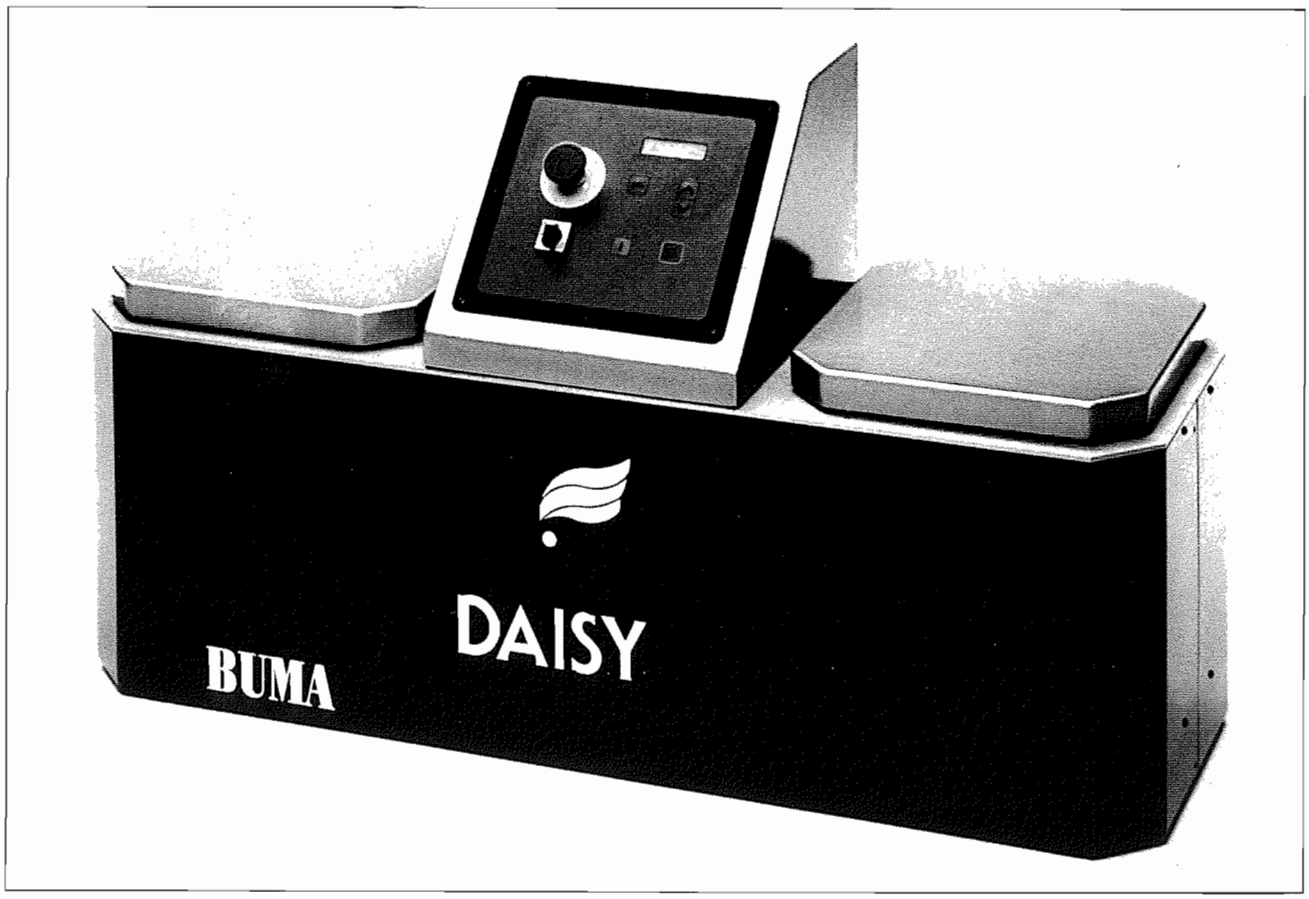
As in all processes, a methodical and systematic approach will increase efficiency and quality of the desired result. The use of the proper materials (abrasives, compounds and polishing wheels) will also increase the success of the finishing or polishing operation.

Mass-Finishing

Platinum jewelry items can be mass-finished in the typical manner of gold or silver jewelry products, such as barrel or vibratory bowl tumbling. However, new magnetic tumblers using a fine steel shot can greatly reduce the time for the burnishing cycle. These new magnetic tumblers have a much more aggressive action that promotes a quicker time to finish or prepare a platinum surface for the final polish.

Hand-Finishing

The common finishing and polishing compounds such as Tripoli, white diamond, green compound and red rouge can be used on platinum, but these compounds are not abrasive enough for the rapid finishing of



Magnetic tumbler for high-speed mass finishing of platinum alloy jewelry products.

platinum jewelry. Finishing and polishing compounds made of aluminum oxide or silicon carbide and imported from Japan are now available in the U. S. These compounds reduce the labor time to finish platinum by 10% to 15%.

A tungsten burnisher can be used to repair a surface that has micro-porosity present. By burnishing the porous surface, one can close minuscule cavities and achieve a high polish on a substandard surface. Not only will burnishing close pits, it will also work harden the surface of platinum jewelry, allowing for a quicker finishing process.

It is important when polishing to keep the polishing buffs, brushes, wheels and laps clean and freshly charged with cutting and finishing compounds. This allows for quicker cutting and polishing because the clean, fresh charge of cutting and polishing compounds are more abrasive when fresh.

Supplies for Finishing and/or Polishing:

- Tungsten burnisher (can be fabricated from drill stock).
- Silicon carbide or aluminum oxide abrasive papers. Grits usually required are #220, #280 and #320.
- Coarse, medium and fine rubber wheels containing silicon carbide or aluminum oxides.
- Unitized or de-burring wheels. The most often used grits are #400, #500 and #600.
- White cutting compound (#800 grit to #8,000 grit) and orange polishing compounds (aluminum oxide) are the compounds recommended to be used in conjunction with stitched flannel muslin buffs and flint-hard laps.

With care and practice, one should be able to produce consis-

tent finishes and brilliant polished surfaces on platinum jewelry. The art of finishing platinum does not lie in previous experiences with other precious metals but in first-hand exposure to the characteristics of platinum.

Brazing and Welding

Although three years ago there were no tools available, this area of platinum manufacturing now has all of the recommended tools and supplies available. The tools and supplies are an alumina brazing pad, tungsten solder pick, tungsten tweezers, welding lenses that provide from #6 to #11 UV protection and zircon oxide (ZrO) paint. *(Note: Always wear ultraviolet protective glasses [welding lenses] when brazing or welding platinum. Use no less than a #6 lens for brazing with 1300°C filler material. Use a #6 to #10 lens for 1500°C and higher filler materials. A #11 lens is recommended for the welding or melting of platinum.)*

Your work area should be for brazing or welding platinum only to help prevent contamination from residual metals on the workbench. Remove the brazing pad from the bench when not in use to prevent filings, grindings, polishing compounds or ferrous materials from impregnating the pad. After the pad has cooled off, place the pad in a large, air-tight bag and put it away in a drawer.

Use cadmium-free karat gold solders when joining platinum to karat gold products. Cadmium can migrate into the inter-metallic grain (crystal) structure and cause brittleness.

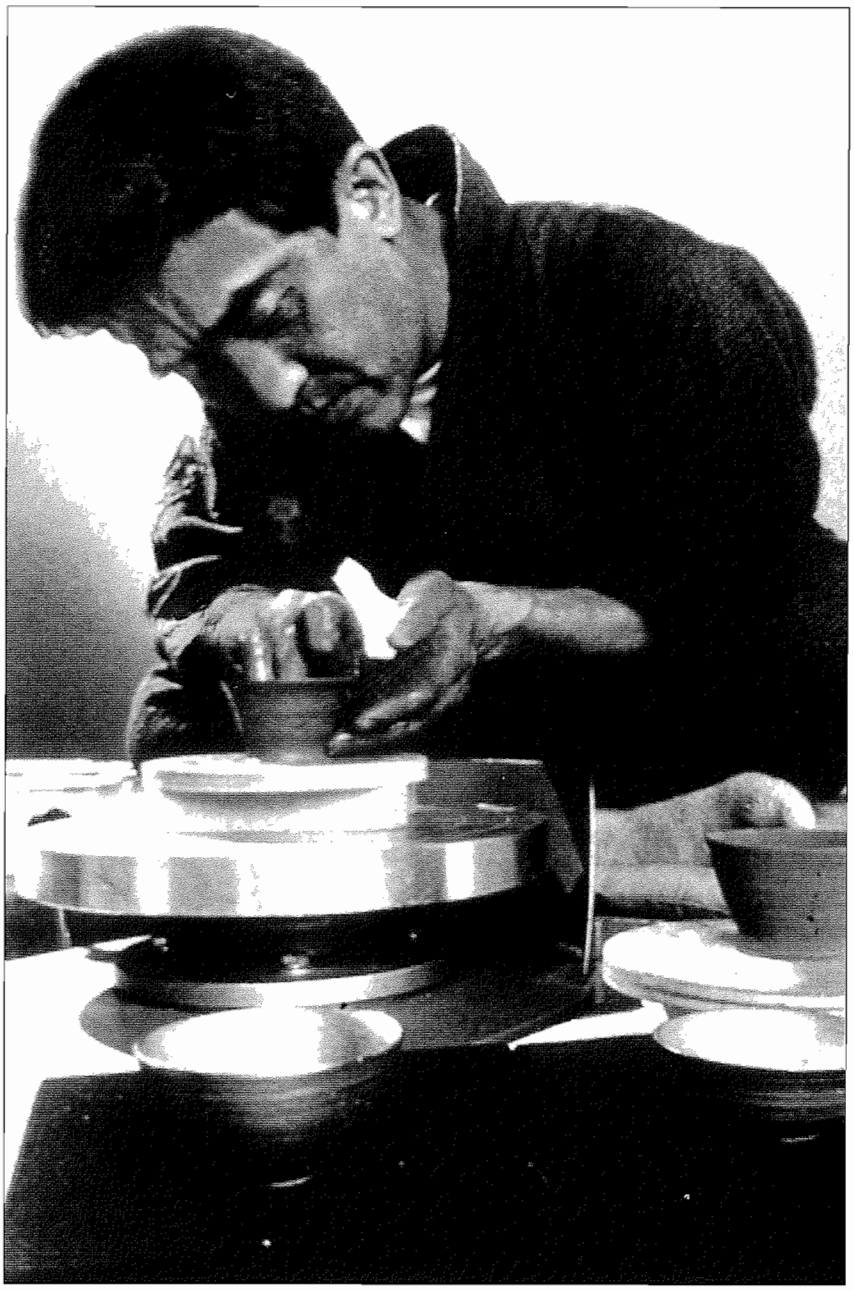
Use a tungsten solder pick when placing platinum solders on hot platinum during brazing. Platinum will be contaminated by steel picks at the red-heat stage of brazing. (Red-heat is between 540°C and 705°C). Tungsten tweezers are to be used when platinum components need to be adjusted during the brazing or welding process.

Always clean platinum in an ultrasonic cleaner, using cleaning solutions to remove oil and grime prior to brazing or welding. Some surface contamination may occur

TABLE COMPARISON OF MANUFACTURIG TECHNIQUES FOR PRECIOUS METAL ACCESSORIES

	PMC	LOST WAX	SCULPTURING	ELECTRO-FORMING	INJECTION MOLDING
EARLY EQUIPMENT INVESTMENT	◆	●	●	▲	▲
NECESSITY OF SKILL	◆	●	▲	●	●
FORMABILITY OF PRODUCTS	◆	●	●	●	◆
ADJUSTMENTS FOR SMALL QUANTITY - MANY TYPES	◆	●	◆	▲	▲
MASS PRODUCTIVITY	▲	◆	●	◆	◆

◆: EXCELLENT ●: Good ▲: FAIR



Manipulating platinum clay on potters wheel.

during cold working, such as when filing, grinding, milling, rolling or sawing. It is best to pickle the platinum item to remove any metallic residue that may be impregnated in the worked surface.

Be sure to polish the platinum component completely prior to joining it to karat gold. This will allow the karat gold alone to be polished after brazing. Gold polishes quicker than platinum. Therefore, the karat gold would be easily over-finished if polished simultaneously with the platinum component.

ZrO paint can be used as a brazing stop-off or parting agent when joining components or when joining platinum to gold. The ZrO paint acts like yellow ochre and will not contaminate platinum at brazing or welding temperatures.

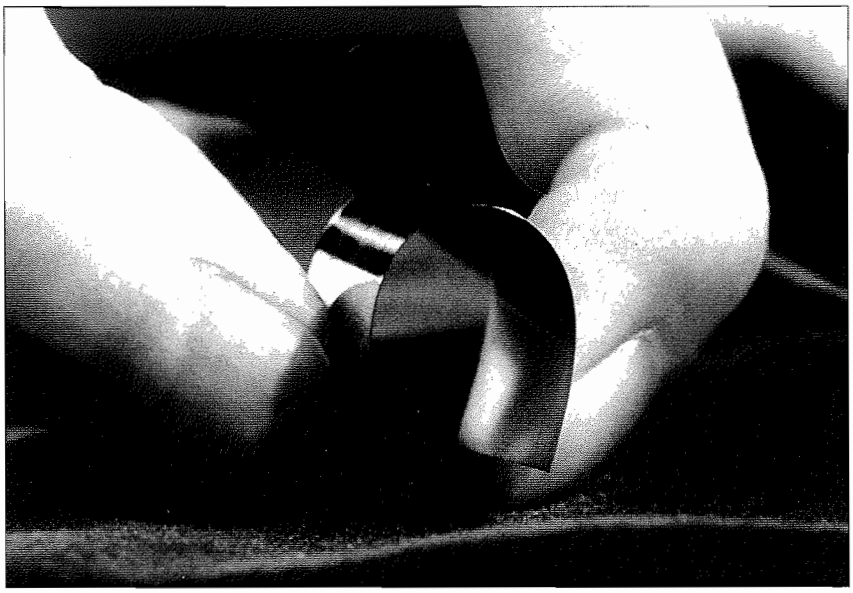
Pure Platinum Precious Metal Clay

Precious metal clay (PMC), or platinum clay, is a mixture of powdered platinum and organic binders, which was developed by Mitsubishi Materials of Japan. This material has undergone extensive research and development and has very predictable characteristics in manufacturing.

Although platinum clay appears to be a simple mixture of metal powder and binder, it promises to be an innovative and ground-breaking material with capabilities not possible with traditional platinum casting alloys.

When one first encounters platinum clay, they will find that it looks and feels like potter's clay. It is soft and pliable, water-soluble and kneads just like clay. In fact, the clay can be placed on a potter's wheel and be spun into bowls, cups, saucers or vases. Due to the binder in the clay there are no messy powders to contend with, thus reducing waste of materials. The clay must be wrapped in a wet towel when not in use to sustain its clay-like qualities.

On first handling the clay, one will notice that it has a tendency to crumble. This can be minimized by putting additional water on the clay while working it.



Platinum sheet manufactured using electroforming process.

Care should be exercised in this procedure; too much water will cause the material to swell from absorption. The binder is water-soluble and feels gelatinous to the touch when wet. Over-hydrating the clay will dissolve the binder and cause subsequent deterioration of the desired product.

The clay is not very dense prior to sintering; the density of the un-sintered product may be increased by rolling with a rolling pin or by pressing the PMC into a prepared mold. A silicon release spray can be used to help relieve the clay from the mold without damaging the un-sintered clay.

Because the un-sintered clay is soft, careful handling prior to sintering is required. The PMC will stick to smooth or rough surfaces when un-sintered. Placing the un-sintered product on wax paper is a simple solution to this problem.

There is shrinkage of 20% to 30% in size and 40% to 50% in weight (this will vary with product size and shape). It should be noted that the sintered PMC has a porous structure, the density is generally about 70% to 80% of an as-cast product. This shrinkage is accounted for in the vaporization of the organic binder during the sintering process. However, the density after sintering is acceptable and can be improved by burnishing or compacting the surface. If the same product is produced in mass-volume, the density, shrinkage and weight loss will become very predictable from one duplicate to the next.

Shrinkage is one of PMC's advantages, allowing one to produce fine detail in an enlarged product that would have been very labor intensive in the reduced sintered product.

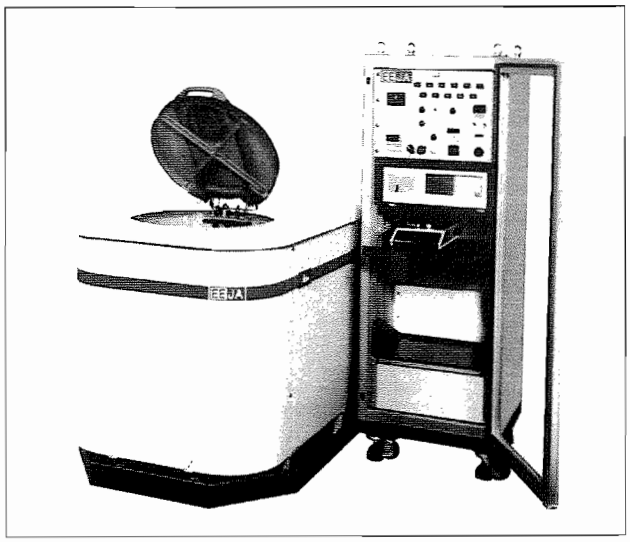
Sintering Of Pure Platinum Clay

The sintering process of the pure platinum clay will require a high-heat furnace. This furnace will have to sustain 1600°C (2912°F) for two hours. The sintering process is a 10-hour schedule, a four-hour ramp to sintering temperature and a four-hour ramp down to room temperature. A reducing or inert atmosphere is not required due to pure platinum's resistance to oxidation. Different times at heat and ramp temperatures will vary with size and volume of desired product.

After the product has been properly sintered it can filed, drilled, sawed and polished like normal cast or fabricated platinum products.

Platinum Electroforming

Electroforming is a metal



Platinum electroforming equipment.

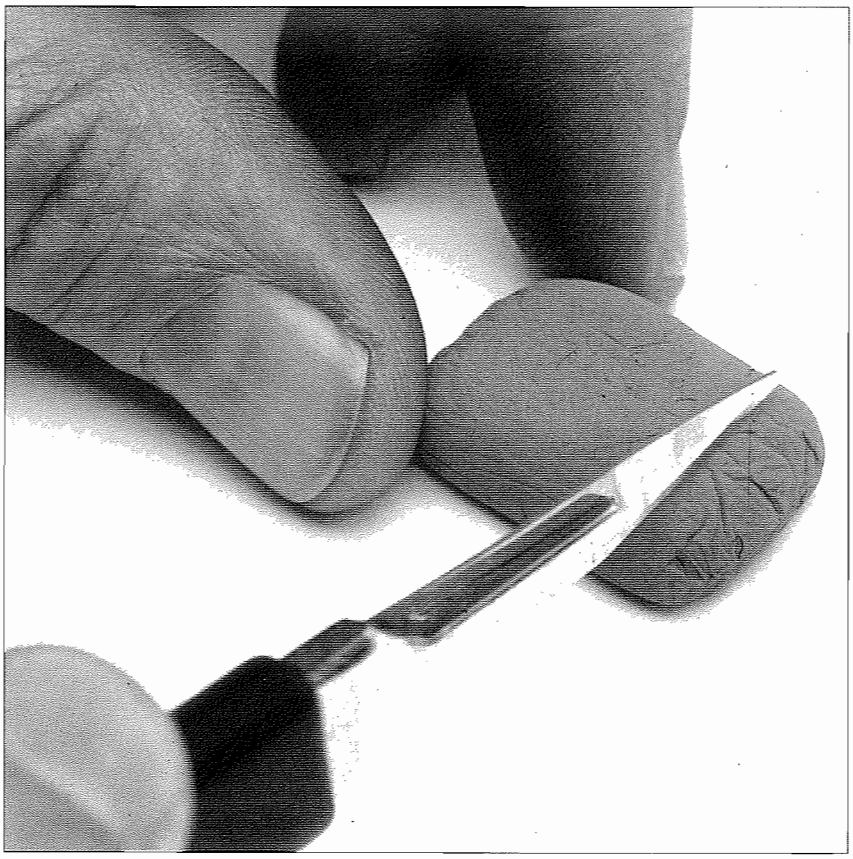
fabrication technique used to duplicate an original model precisely by means of electro-deposition provided by an electrolytic process. Compared with ordinary casting, stamping and mechanical manufacturing, electroforming allows thinner and more precise fabrication.

Although this method of producing jewelry items has been used in gold, silver, copper and nickel, it has never been commercially used in platinum. Platinum's drawbacks have been susceptibility of electroplated films to fracture due to high levels of internal stress and unstable speeds of deposition caused by hydrogen generated during electro-deposition.

To solve these problems, new platinum compounds, additives and devices have been developed exclusively for platinum. This research and development conducted has produced for the first time in the jewelry industry an electroplated film in excess of 300 microns without internal stress or strain.

Advantages And Features Of Platinum Electroforming

- Three-dimensional products can be made from a small amount of platinum.
- Complicated designs can be manufactured.
- Platinum products with a fineness close to 100% can be made.
- The hardness of electroformed platinum (300Hv) is roughly five times the hardness of ordinary platinum and is highly resistant to wear. It resists cracking and is also flexible, which is an original property of platinum.
- As the waste of electrolytic process does not accumulate,



Cutting platinum clay using ordinary scalpel.

One ounce of platinum clay.

the life of electrolytic solution is extended.
- Electro-deposition speed is 10 to 15 times the speed of ordinary solution (one micron thick film can be deposited in two to three minutes).
- A film thickness in excess of 300 microns can be deposited.
- Internal stress or strain is seldom observed.

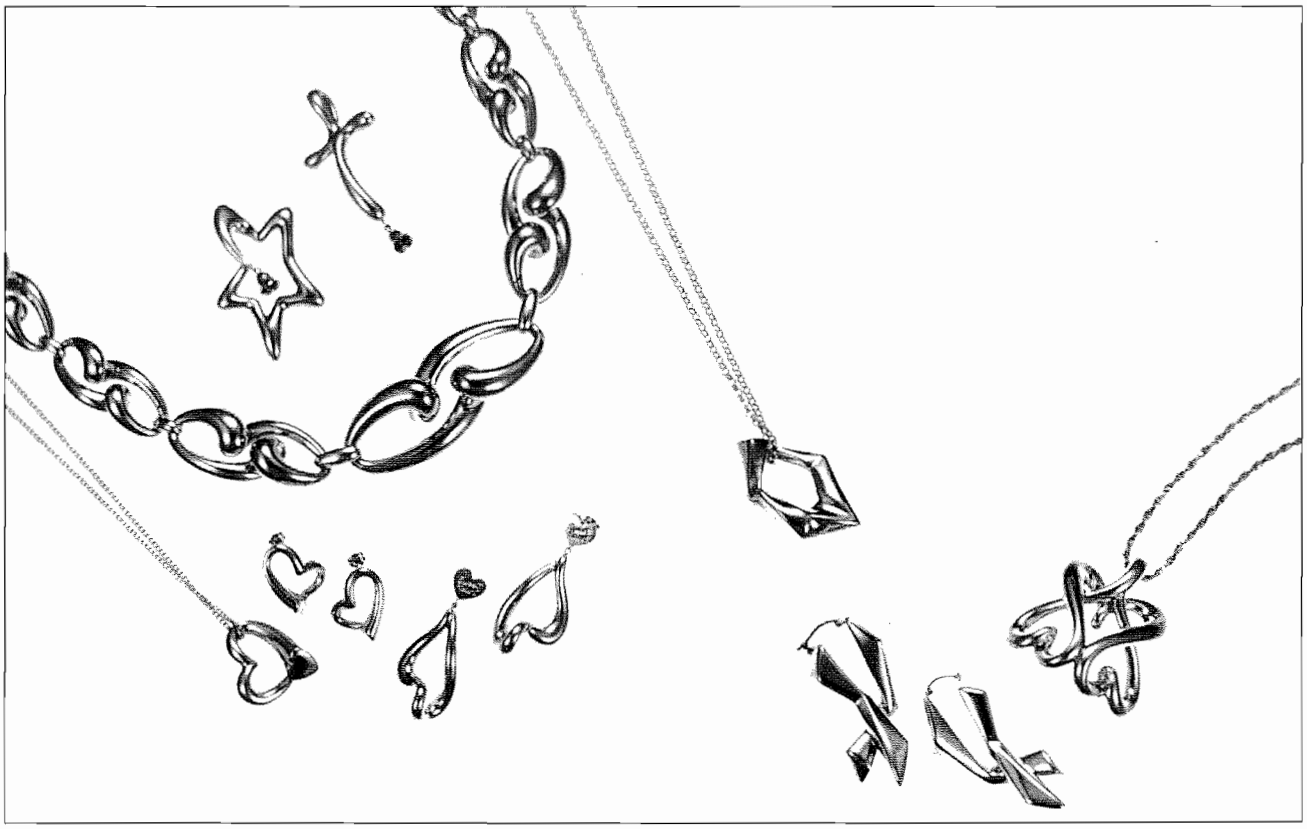
The Platinum Electroforming Process

In the platinum electroforming process the model can be design-cast or molded from a variety of materials. The choice depends on a number of factors, including type of component to be made, size, quality required and production quantity. Typical materials are fusible alloys such as brass or silver. These models are cast in the selected metal in the normal processes required of lost wax casting.

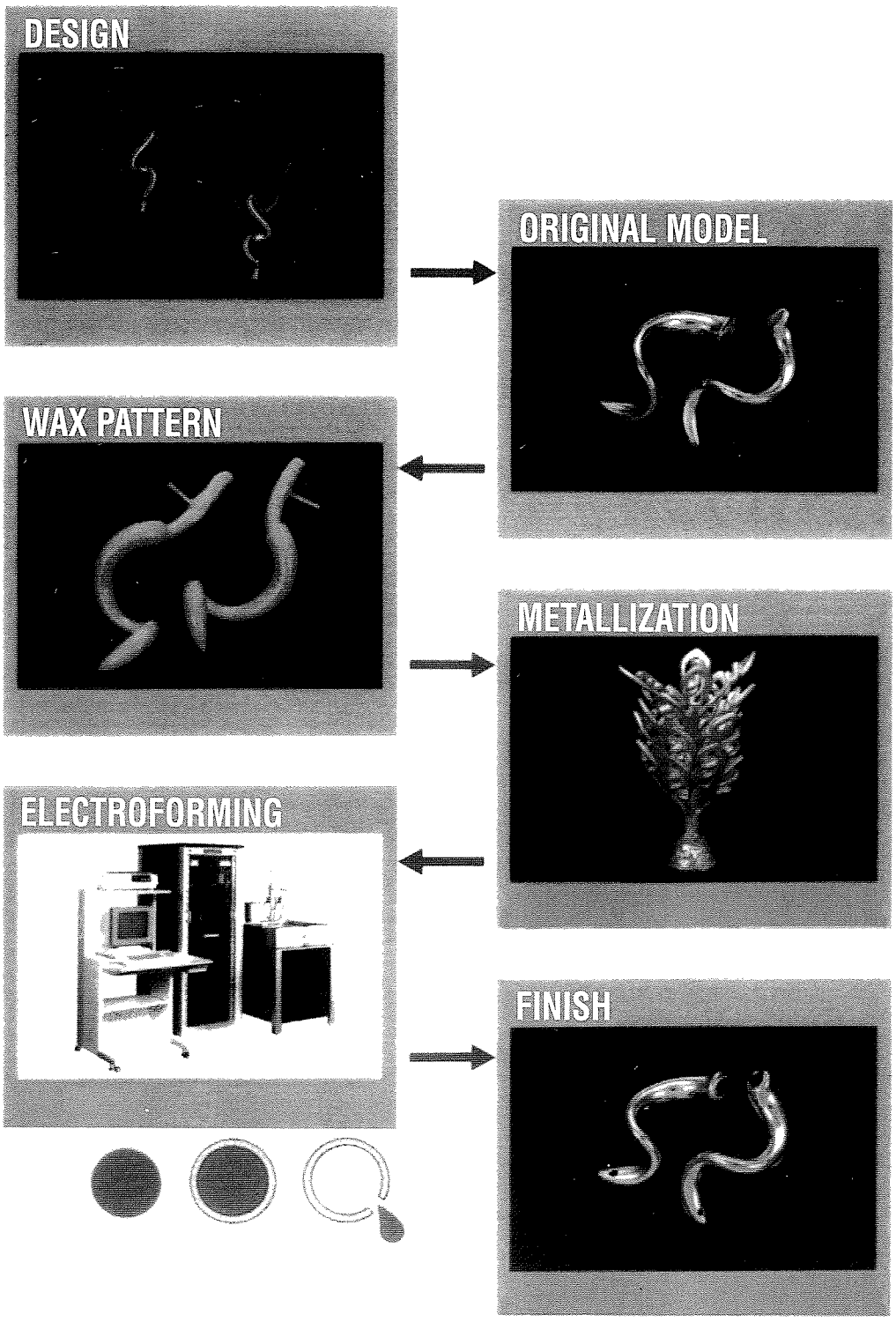
The models are duplicated in rubber molds to provide a wax for mass production casting. Short wax vents should be placed at opposite ends of the wax model to provide an exit for the internal core metals after deposition.

Having cast the production models in the selected metal, the next procedure is to clip the sprues, leaving the vents on the model in preparation for electro-deposition. Surface finish is crucial at this point in the process because electroplating replicates the exact surface that exists on the model. Electroforming is not restricted to a high polish and will adhere to a matte, brush or textured surface.

The next step is to mount the models on a plating rack. Correct mounting of the models on the plating racks is very important in obtaining optimum thickness and homogeneity of the resulting electroforms. These metallic models must be thoroughly cleaned and de-greased prior to electroforming. Failure to clean the models completely will inhibit the deposition of the electroplate.



Various electroformed platinum jewelry products.



Overview of electronforming process.

Hollow electronforming earrings before and after assembly.

Once the product is in the electroplating bath the typical plating rate is one micron per two and a half minutes. The deposition time is in the range of four to six hours, depending on the desired thickness.

After the products have been electroformed the internal metal core can be melted out with the remaining traces removed with nitric acid. Silver, brass and copper cores can be removed by chemical dissolution alone, as in nitric acid baths.

Heat treating the hollow platinum electroform will ensure that the electro-deposits are ductile and homogenous. This can be achieved by placing the parts in a furnace at a temperature of 400°C or 752°F for 30 minutes. A final polish or finish can be applied at this point to produce the end product.

As stated previously, platinum electroforming can produce highly complicated, three dimensional products that are aesthetically pleasing and relatively light in weight.

Summary

As with all new processes, cost will diminish as methods and materials are made cost effective and become more readily available. Through further experimentation, especially within the jewelry industry, these processes will increase the gross product yield and produce high-quality platinum jewelry products. ◆