WORKING PALLADIUM

With the resurgence and increased popularity of palladium for jewelry design and manufacturing comes the need to examine its unique working characteristics. In a series of technical briefs extracted from their evolving palladium technical manual, Johnson Matthey New York will identify the optimal manufacturing opportunities for this intriguing 'new' metal.

950 Palladium Bench Basics

General Comparative White Jewelry Metal Statistics

	950Pd	950Pt	14-karat AuNi
Specific Gravity	11.8	20.7	12.7
Vickers Hardness	115	130	165
Whiteness	White	White	Off-white
Malleability	Very good	Very good	Poor

Soldering, Ring Sizing and General Alterations

- For torch work such as soldering or annealing, protective eyewear must be worn along with using a No. 5 rated or higher welding lens.
- Use a platinum soldering block and high-heat tweezers to hold pieces for soldering or annealing.
- No firecoat or flux is necessary when soldering 950 palladium alloys but a surface oxidation appears when heated to high soldering temperatures. This blue-violet color on the surface of the ring is easily and quickly removed with a neutral flame (equal parts of gas and oxygen).
- Palladium also loses its polished luster when heated to soldering temperatures but this is quickly restored using very fine abrasives or polishing compounds.
- Directly heat joints being soldered with an oxidizing flame.
- When sizing a 950Pd ring up or down use hard palladium solder. If palladium solder is not available, 1,300 platinum solder will work but will need to be burnished to help conceal any resultant slightly off-color solder seam.
- Torch welding of ring sizing joints is difficult. Palladium absorbs oxygen when excessively heated or melted and attempts to give it off during its cooling cycle, resulting in pits, cracking and failure when worn.
- Use gold soldering procedures for bonding gold to palladium. Soldering gold to palladium yields excellent results.

Pre-finishing, Finishing and Polishing

- Pre-finishing, finishing and polishing 950 palladium requires one or two more steps than with white gold.
- For the absolute best results use files, abrasives and polishing materials dedicated for 950 palladium.
- 950 palladium alloys quickly and easily clean and brighten during tumbling and magnetic finishing procedures and extra fine rouge as a final step creates a scratch free luster.
- Magnetic finishing also restores palladium's polished luster after soldering procedures.
- NO rhodium or other plating is required to improve the color or final finish of 950 palladium alloys.

Casting

- With palladiums hunger for oxygen, use of an induction melt casting machine with a sealed melt chamber and an argon cover offers the best results. Casting is, therefore, best accomplished by an experienced palladium casting facility.

Setting

- 950 palladium is comparable to platinum for setting with little or no memory as the prong, bezel, channel or other setting metal is bent or formed to secure gemstones.

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Soldering a palladium ring that has been sized up.

Annealing palladium wire on a high heat soldering block and viewing work through a No.5 rated welding lens.

Blue-violet surface oxidation after soldering setting into shank.

Using a hard felt wheel and rouge for preliminary final polish.

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Service and Everyday Applications

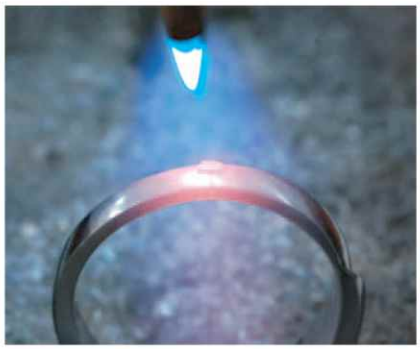

Fig. 1

Palladium Ring Sizing

- Begin by cutting the shank as you would when sizing a ring in any metal. Remove or add metal to adjust the size as needed and realign the shank making a good butt joint with no gaps, spaces or other irregularities.

Fig. 4

Removing surface marks

- When heated to high heat soldering temperatures, palladium loses its polished luster and will often take on a blue-violet surface discoloration (Fig. 4). This is easily removed by using a neutral flame (equal parts of gas and oxygen) for 10 to 20 seconds. The discoloration can also be removed mechanically with fine abrasives and with polishing compound. Pickling does NOT remove the discoloration.

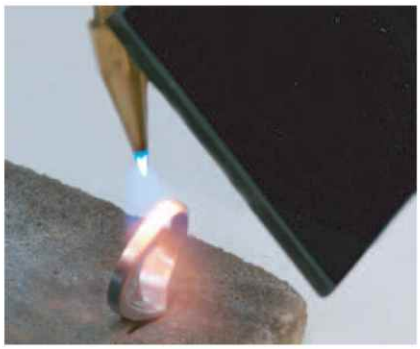

Fig. 2

- Use a small piece of hard palladium, or 1300 platinum, solder at the joint (Fig. 1 - 1300 platinum solder with a melting point of 2660°F was used here). Place the ring on a high heat soldering block (Fig. 2) or hold with tungsten, titanium or ceramic-tipped tweezers. Directly heat the joint with an oxidizing flame to melt. Use the flame, on the joint and flow the solder. View the work through a No. 5 rated welding lens or goggles. No flux of fire-coating is needed with 950 palladium alloys.

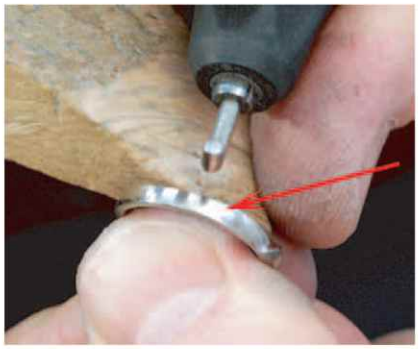

Fig. 5

- The red arrow indicates 2 minor pits in the side of the shank. With palladium's malleability, the pits are easily removed by burnishing. In the image above (Fig. 5), a rocker arm burnisher was used for a few seconds to compact metal into the voided area. Fine abrasives are used to polish palladium. The recommended steps are medium and fine abrasives - 2 or 3 steps only. In this example, a medium rubberized abrasive wheel containing ceramic abrasive is used to smooth the burnished area and the solder joint.

Fig. 3

- For sizing and general purpose soldering, hard, medium and easy palladium solder is available but you can also use 1000, 1100, 1200 and 1300 platinum solders. The lower melting point platinum solders contain no platinum - just palladium, gold and silver - so they are acceptable for use with palladium. You can see a very faint line on this shank (Fig. 3) as the solder is slightly darker than the alloy. A perfect color match is yet to be achieved, regardless of which solder is used, but burnishing and high polishing will make the joint very difficult to detect.

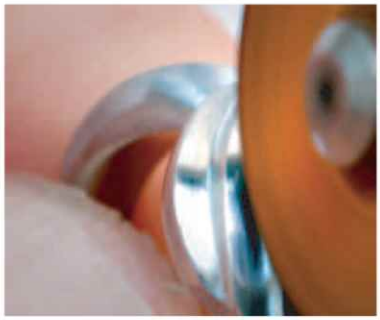

Fig. 6

The ring featured in this article is made from Johnson Matthey's 950 palladium casting alloy.

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Pre-finishing Palladium Castings

- The rings (Fig.1) were cast by Techform, using Johnson Matthey's 950 palladium alloy (as-cast hardness 150 - 165 HV). Following the pre-finishing techniques in this feature, enabled a one-step final polish using Bendick® White Rouge, and provided a long lasting, lustrous shine.

Fig. 1

- The surface of palladium castings is characteristically coarser than that of gold due to the different nature of the materials used in the process and requires a variety of pre-finishing methods.
- Use a rotary bur and a #2 cut file to remove any excess metal formed by the gates on the inner surface of the ring shanks.
- Round on a mandrel using a rawhide mallet before and after smoothing the inside of the rings.
- Smooth the inside of the inside surfaces of the rings using either 3M's® Diamond 400 and 800 grit _ inch sanding drums (Fig. 2) or 3M® ceramic purple 1 inch, coated abrasive 120 grit drum mounted in a small bench rotary machine (Fig. 3). Both methods are faster than using a #2 cut file.

Fig. 2

Fig. 3

- Continue pre-finishing using finer files, sanding abrasives or rubberized abrasive wheels, e.g. 3M's® Imperial Lapping Film (Fig. 4) followed by a final grit of 1200 to get a consistently flat, fine grade semi-polished surface.

Fig. 4

- Smooth the outside surfaces of rings using sanding sticks (Fig. 5) of progressive grits ranging from 200 to 1200.

Fig. 5

- Use abrasive strips cut from 3M's® Imperial Lapping Film thrum between upper and lower galleries (Fig. 6) - ideally three progressively finer grits.

Fig. 6

- Use small mounted rubberized abrasive points to refine recessed areas (Fig. 7) - use three grits ranging from 400 to 1000.

Fig. 7

- Sanding sticks and fine files work well to prepare the outside portion of the shank for final polishing but an alternative is Foredom's® rubberized wheels that contain ceramic abrasives - three progressive grits ranging from 400 to 1200 (Fig 8).

Fig. 8

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Burnishing

Burnishing is the process of compacting and smoothing the surface while simultaneously making it harder. Use of oil reduces friction, making the burnishing process less abrasive and virtually effortless to accomplish. Techniques include: Burnish-filing, where pressure is continually applied on both the forward (cutting) stoke and the back (burnishing) stroke of a No. 6 cut file. Rotation hammering, where a small, highly polished "L" shaped bit mounted in a flexible shaft hand piece strikes the metal with each rotation, compacting and manipulating the surface to close voids and smooth imperfections. Hand burnishing, where the surface is rubbed and smoothed using a highly polished tungsten carbide steel burnishing tool. Rotary burnishing, where manual pressure and control is applied using a highly polished, tungsten carbide steel, rotary burnisher (see Fig.1) to rub over and compress the metal surface.


Fig. 1


Fig. 2


Fig. 3


Fig. 4


Fig. 5

Note:

For palladium, polishing is most efficiently accomplished after 1,200 grit or higher abrasives have been used to pre-finish the surface (see technical brief on Pre-finishing Palladium Castings).

It is important to clean the piece between each step and for the best results use dedicated and grit specific pre-finishing materials and polishing wheels for your palladium production.

Polishing using Non-traditional, non-compound polishing methods:

Maintain the burnished surface by polishing with abrasives of 2,000 grit or higher. Coarser grits could grind below the carefully burnished surface, risking the exposure of additional voids.

Bring out the luster using 4,000 grit or finer abrasives to produce a luster on the surface, (Fig.2) - Using 8,000 grit 3M Imperial Lapping Film®.

Maintain contours, unique part geometries and complex shapes using Green 3M FX® wheels (Fig.3). These are made of a foam-like resin which 'gives' with pressure and are preloaded with 240 to 3,000 silicon carbide so there is no need for polishing compounds.

Reach hard-to-access areas, using 3M Radial Bristle Discs® (Fig.4) are also preloaded with 80 to 8,000 abrasive so finer polishing can be achieved with out the need for additional compounds and traditional cotton or felt wheels.


Fig. 6


Fig. 7

Polishing using Traditional polishing methods:

Roughly pre-finished items require a 2-step polishing process. For the first step use Tripoli on polishing brushes for detailed and intricate areas (Fig.5) and on felt wheels (Fig.6) charged with traditional Tripoli or white rouge or a standard yellow stitched buff on flat surfaces. Conclude the process by using Bendick® Platinum White Rouge (6,000 or 8,000 grit) with a non-treated loose polishing wheel (Fig.7).

For items that have been finely pre-finished a one-step polishing process is all that is required. A final buff on a non-treated loose polishing wheel using Bendick® Platinum White (6,000 grit) Rouge will provide a stunning white lustrous finish.

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This feature covers Gemstone Setting Techniques for 950 palladium.

Creating a 'Bearing' or 'Seat'

To create a bearing or seat for gemstones in palladium settings, use the appropriate cutting tools. For larger prongs, as in Fig. 1 high speed steel burrs are recommended.

For lighter prongs, as in Fig. 3 non-aggressive burrs are most effective. Use setting burrs when cutting all prongs simultaneously and 70 or 90 degree bearing burrs to cut prongs one at a time. The flashing of metal on each prong caused by the burrs should be removed prior to setting.


Fig. 1 David Lee and Brenda Neisham Fuller

Guideline metal removal percentages for palladium settings

Prongs	35 to 40% metal removal (leaving 60% of the original prong thickness).
Bezels	About 35 to 45% of the original bezel thickness, if the total thickness is greater than 1.5mm.
Channel	Opposing notches should cover 10 to 12% of the gemstone diameter, but walls should be substantial enough to allow for these parameters.
Shared Prongs	Remove 30 to 40% of the prong but ensure adjacent gemstones will not come in contact with each other as they are set.


Fig. 2


Fig. 3

Note:

One jaw of the pliers in Fig. 3 supports the prong opposite the one which is being set.

Although palladium forms and shapes nicely around gemstones use of thicker prongs, bezels and channel walls are preferable to secure the gems and support the overall structure of the article of jewelry during normal wear.

Palladium has little or no memory, which means it does not spring back after being bent and formed over a gemstone.

Pre-polishing palladium settings prior to setting provides a better finish and saves time.

Securing Gemstones

In Fig. 2, a cabochon is being hammer-set in its bezel setting using a Foredom Micro Motor® reciprocating hammer hand-piece. Adjust 'impact' to medium as palladium is malleable and forms without difficulty. The thickness of the remaining bezel frame is 1.0mm.

In Fig. 3, 60 to 65% of the original prong thickness remains and is formed over the crown of the gemstone. Since these prongs have a narrow profile, it is very important that the remaining metal thickness is sufficient to maintain the shape and security of the setting through normal wear.

In Fig. 4, a single heavy prong is being formed around a colored gemstone. Palladium is ideal for this style of setting given its malleability and lack of 'memory'.

The wide channel walls in Fig. 5, offer ample security for gemstones. When using channels, prongs or bezels, avoid high profiles with thin narrow widths as these features will tend to be vulnerable to distortion during normal wear.

Fig. 6 shows a palladium ring, with graduated diamonds channel set into it. The width of the channel walls tapers in thickness as the size of the diamonds decreases.


Fig. 4 David Lee and Brenda Neisham Fuller


Fig. 5


Fig. 6

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Tips for Laser Welding Palladium

This feature covers the use of a laser welder with palladium alloys for tacking and assembly, filling voids and sizing rings. Laser welding units vary by unit and manufacturer so the settings listed are offered as a general reference.

Tacking and Assembly

For assembly of palladium or palladium and gold pieces, it is better to tack the parts and then torch solder. In Fig. 1 and 2 the parts were tacked with a laser to hold them in place prior to soldering. Procedure variables depend upon the size of the components being joined but in both these cases 250 Volts, 5 to 10 ms, 1.3Hz with a beam or focus of 5 to 15 was used.

Fig. 1

Fig. 2

Important Notes:

To avoid gas absorbtion use 99% pure argon and set the dispenser(s) 1 to 1.5 inches from the work piece and with enough pressure to surround the piece being welded with argon.

Use pulse shaping techniques to avoid over-heating of the material. Begin the series wih high laser intensity and then incrementally reduce the laser power once the melting point has been reached. This also reduces cracking which can occur during quick cooling of a weld.

Filling Voids

Voids or pits result during the manufacturing process with all jewelry alloys, including 950Pd. To repair these irregularities with a laser use 32 gauge dead soft 950Pd wire and use 250 Volts, 5 to 10 ms, 1.3Hz with a beam or focus of 5 to 15, although variables depend upon the size and depth of the void. First hit the open void with a few pulses of energy to expose fresh metal from which to build on and to shape it. Place the tip of the wire in direct contact with the palladium piece at the void (Fig. 3). Overfill the void and then file flat as in Fig. 4.

Fig. 3

Ring Sizing

Use 32 gauge (or smaller) dead soft round wire of the same alloy for filler material for best results. Settings can vary with different equipment and the person using it but Fig. 5 shows an example of one successful process using 290 Volts, 10.0 ms and 1.3 Hz with a beam or focus of 15 on a flat joint with angles filed around it. A thin piece of the same alloy rolled down to 0.15 to 0.20 mm was inserted and the central area welded first before building up around it using 32 gauge wire. Adjusting the milliseconds to high levels will spread the energy throughout the metal.

This technique helps avoid excessively hot concentrated areas which may make the palladium brittle in that specific area. Alternatively a "V" joint could be used, welding the keyhole first without filler material using 200 volts, 3.2 ms and 9Hz with a 0.25mm beam diameter and then using filler material to build up the void.

Fig. 4 Craig Warburton

Suggested pulse shaping settings for 950 palladium alloys:

Reference	X (Pulse Duration)	Y (Total Energy)
1	0%	90%
2	20%	100%
3	40%	100%
4	50%	70%
5	80%	30%
6	100%	20%

Fig. 5

Technical contributions by Brenda Warburton, Austin & Warburton, Ann Arbor, MI and Brody Rice, Thomas Dailing Designs, Stevens Point, WI.

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Refining Palladium: The Six "C's" To Bring The Best Returns


Collect filings with a vacuum


Use a dedicated bench area


Keep a clean bench

Scrap Metal Retrieval Techniques

This feature covers a general overview of bench practices suggested for the most efficient retrieval of metal from palladium jewelry manufacturing processes. Palladium scrap can be even more complex and costly to refine than platinum so for maximum returns, the process must begin long before you 'box up' the metal to send to the refiner.

Collect Metals Separately

Collect like metal separately. Do NOT mix palladium scrap with gold, silver, base metals, or even platinum - your return will be far greater with palladium-only submissions to your refiner. In addition, collect until you have sufficient quantity to make refining cost effective per your refiner's terms. Screen investment waste from any casting processes for hard metallic scrap.

Categorize Your Scrap

Keep separate:

Hard metallic scrap - worn rings, failed castings, buttons and pieces from fabrication.

Filings - bench filings, grinding scrap, machining swarf.

Polishing Sweeps - dust from polishing machine and debris from dedicated pre-finishing stations.

Cleanliness = Better Returns

When beginning a palladium project at the bench, clean away the debris from previous projects. This will help you in avoiding working contamination and increase your palladium return on filings and hard metallic scrap.

Check Your Refiner's Terms

Understand refiners' submission policies, pricing schedule and procedure for settlement, which should be clearly published, and follow their instructions carefully. You can maximize returns simply by following their guidelines (e.g. submitting sufficient quantity of scrap to avoid minimum handling costs). Check that they are following their published handling procedures, especially turnaround times and how you receive out-turns. If your palladium alloys contain other platinum group metals, ask your refiner for return on this metal too.

Careful Packing and Shipping

Pack your scrap carefully in tamper-proof sealed containers and include instructions to your refiner to notify you if the seal is broken. Use containers with friction lids and smooth rims. Waste metal can "hang back" in containers with screw-top threading and get trapped in the tracks of the seal in plastic interlock-top bags. **Insure** your shipment for the anticipated value of your return, record details and retain all transaction records.

Communicate With Your Refiner

Be clear about how you wish to have your return processed. Most refiners offer choices such as receiving a credit on future purchases of metal or cash settlements. This gives you the opportunity to select the best option for your business model.

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