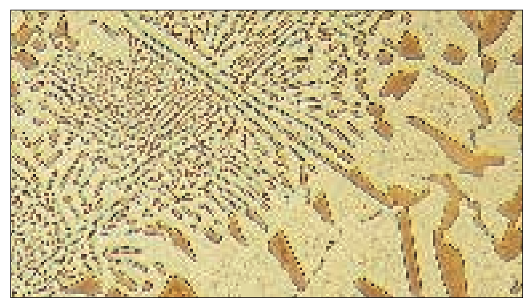
PRECIOUS METALS: Au, Ag, Ir, Os, Pd, Pt, Rh and Ru

Relatively few metallographers work with precious metals, other than those used in electronic devices. Preparing precious metals within an integrated circuit is discussed later (see Microelectronic Devices). The precious metals are very soft and ductile, deform and smear easily, and are quite challenging to prepare. Pure gold is very soft and the most malleable metal known. Alloys, which are more commonly encountered, are harder and somewhat easier to prepare. Gold is difficult to etch. Silver is very soft and ductile and prone to surface damage from deformation. Embedding of abrasives is a common problem with both gold and silver and their alloys. Iridium is much harder and more easily prepared. Osmium is rarely encountered in its pure form, even its alloys are infrequent subjects for metallographers. Damaged surface layers are easily produced and grinding and polishing rates are low. It is quite difficult to prepare. Palladium is malleable and not as difficult to prepare as most of the precious metals. Platinum is soft and malleable. Its alloys are more commonly encountered. Abrasive embedment is a problem with Pt and its alloys. Rhodium is a hard metal and is relatively easy to prepare. Rh is sensitive to surface damage in sectioning and grinding. Ruthenium is a hard, brittle metal that is not too difficult to prepare.

Stewart (Tech-Notes, Vol. 2, Issue 5) has described a method for preparing jewelry alloys. Invariably, these are small pieces, due to their cost, and must be mounted. Stewart uses EpoMet G resin for most specimens. If transparency is need, he uses TransOptic resin. Fragile beads and balls are mounted in castable resins. Grinding and polishing was conducted at 400 rpm. His practice is shown in Table 28.



Eutectic microstructure of Ag – 28% Cu where Klemm's reagent has colored the copper particles and the silver phase is uncolored (500X).

Table 28: Stewart's Manual Procedure for Precious Metals

Sectioning	Precision Saw with a blade recommended for use on soft gummer materials
Mounting	Castable, typically with EpoThin

Surface	Abrasive / Size	Load - lbs [N] / Specimen	Base Speed [rpm]	Time [min:sec]
CarbiMet 2	240 [P280] grit SiC water cooled (wax coated)*	Moderate	400	Until Plane
CarbiMet 2	320 [P400] grit SiC water cooled (wax coated)*	Moderate	400	1:00
CarbiMet 2	400 [P600] grit SiC water cooled (wax coated)*	Moderate	400	1:00
CarbiMet 2	600 [P1200] grit SiC water cooled (wax coated)*	Moderate	400	1:00
TriDent	6µm MetaDi Supreme Diamond**	Moderate	400	2:00
MasterTex	1µm MetaDi Supreme Diamond**	Moderate	400	2:00

**Rub candle was lightly across rotating disc prior to grinding* ***Plus MetaDi Fluid Extender as desired*

Imaging & Analysis	Porosity Assessment, OmniMet Object Measurements, Measurement & Analysis Applications
Hardness Testing	Vickers, Knoop

Precious Metals

This can be followed by a brief vibratory polish using colloidal silica on MasterTex, ChemoMet or Micro-Cloth pads to further enhance the quality of the preparation; but, a 1µm diamond finish is adequate for most work. Attack-polishing has been used to prepare gold and its alloys and chemical polishing has been performed after mechanical polishing of silver, but neither practice is commonly performed. Alternate etch-polish cycles may be needed to remove fine polishing scratches, especially for annealed specimens.

A procedure for an automated system was developed after experimentation with a number of precious metal specimens. Most of these metals and alloys are quite soft, unless they have been cold worked, and they are susceptible to embedding of abrasives. In this method, only one silicon carbide step is used. TexMet pads are used for the diamond steps, as it will hold the abrasive in its surface well, which minimizes embedding. Only diamond paste is used, as slurries will be more prone to embedding, as we observed in high gold alloys. Use only a small amount of distilled water as the lubricant. Do not get the cloth excessively wet. Final polishing is with a ChemoMet I cloth and MasterPrep alumina. Due to their excellent corrosion resistance, colloidal silica is not effective as an abrasive for precious metals. The ChemoMet pad has many fine pores to hold the abrasive. The cycle is given in Table 29.

For 18 karat gold and higher (≥75% Au), it is necessary to use an attack polish agent in the final step. An aqueous solution of 5g CrO_3 in 100mℓ water works well. Mix 10mℓ of the attack polish agent with 50mℓ of MasterPrep suspension. This will thicken, so add about 20-30mℓ water to make it thinner. A 3 to 6 minute attack polish step will remove the fine polishing scratches. Wear protective gloves as the chromium trioxide solution is a strong oxidizer.

Equiaxed grain structure of cold rolled and annealed 18-karat gold (Neyoro 28A: 75% Au – 22% Ag – 3% Ni) revealing annealing twins (equal parts 10% NaCN and 30% H_2O_2, 50X).

Table 29: 5-Step Method for Precious Metals

Sectioning	Precision Saw with a blade recommended for use on soft gummer materials				
Mounting	Castable, typically with EpoThin				
Surface	**Abrasive / Size**	**Load - lbs [N] / Specimen**	**Base Speed [rpm]**	**Relative Rotation**	**Time [min:sec]**
CarbiMet 2	320 [P400] grit SiC water cooled	3 [13]	300		Until Plane
TexMet C	9µm MetaDi Supreme Diamond*	3 [13]	150		5:00
TexMet C	3µm MetaDi Supreme Diamond*	3 [13]	150		3:00
TexMet C	1µm MetaDi Supreme Diamond*	3 [13]	150		2:00
ChemoMet	0.05µm MasterPrep Alumina	6 [27]	150		2:00

= Platen *= Specimen Holder* **Plus MetaDi Fluid Extender as desired*

Imaging & Analysis	Porosity Assesment, OmniMet Object Measurements, Measurement & Analysis Applications
Hardness Testing	Vickers, Knoop