PETER W BECK

Precious Metal Services®
Catalogue

Peter W Beck Pty Ltd has been serving the manufacturing jewellers of Australia for over thirty years, in that time we have gained a wealth of experience in developing Precious Metal Services and alloys. Our vast experience in the jewellery industry makes it possible for us to offer the highest quality products and unequalled technical support. Whether you require Alloys, Solders, Casting and Moulding or our Refining and Assaying services, this catalogue is your one stop reference source designed to help you make an informed decision on which metals or services will suit you best.

PETER W BECK

Catalogue Index

Contact us

Peter W Beck Pty Ltd
Head Office
14 Duncan Court,
Ottoway Park, South Australia 5013
Australia
Toll Free (within Australia) 1800 888 528
Telephone 08 8447 1133
Facsimile 08 8447 1144
International Telephone +61 8 8447 1133
International Facsimile +61 8 8447 1144
Email contactus@pwbeck.com.au

Precious Metal Services
Toll Free (within Australia) 1800 888 590
Telephone 08 8440 3399
Facsimile 08 8447 1144
Email preciousmetals@pwbeck.com.au

Wedding Rings & Jewellery
Toll Free (within Australia) 1800 888 585
Telephone 08 8440 3300
Facsimile 08 8447 1144
Email rings.jewellery@pwbeck.com.au

Peter W Beck Pty Ltd
Brisbane Sales Office
Suite 5, Level 4
141 Queen Street,
Brisbane, Queensland 4000
Australia
Telephone 07 3316 2000
Facsimile 07 3012 8749
Email brisbane@pwbeck.com.au

www.pwbeck.com.au

ABN 37 008 011 550

Our specialised Precious Metal Services team are fully trained to answer all your questions regarding prices and availability. For more information about any of our products and services, please call, fax or email us to receive a prompt reply and of course the best personal service.

Alloys & Solders

As precious metal specialists, we manufacture a full range of carated Gold, Silver, Platinum and Palladium alloys designed specifically for the manufacturing jeweller. These alloys come in several forms including standard gauge wire, casting and fabricating granules, wire, sheet, solders and master alloys.

Peter W Beck Precious Metal Services®

Toll Free 1800 888 590
Telephone 08 8440 3399
Facsimile 08 8447 1144
Email preciousmetals@pwbeck.com.au
Web www.pwbeck.com.au

Alloys & Solders Index

PETER W BECK

At Peter W Beck Pty Ltd we are continuously developing and improving our product range, as a consequence we reserve the right to alter product specifications without notice.

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Fabrication Alloys

Peter W Beck Precious Metal Services®

Toll Free 1800 888 590
Telephone 08 8440 3399
Facsimile 08 8447 1144
Email preciousmetals@pwbeck.com.au
Web www.pwbeck.com.au

PETER W BECK

Icon Bar Definitions

THE ICON BAR IS INTENDED TO BE USED AS A QUICK REFERENCE GUIDE FOR THE AVAILABLE FORMS OF EACH OF THE ALLOYS. BELOW IS A BRIEF DESCRIPTION OF EACH ICON. FOR A MORE COMPREHENSIVE LIST OF THE DIMENSIONS AVAILABLE, PLEASE TURN TO THE AVAILABLE FORMS TABLES WITHIN THIS SECTION.

GR - Granules

Granules are available in fine metals, fabrication alloys, casting alloys and master alloys.

SGW - Standard Gauge Wire

Available in 4.5mm or 6.0mm square wire form. Supplied fully annealed.

RW - Round Wire

Supplied half hard as standard.

HR - Half Round Wire

Available in 2 profiles:

True Half Round 50%
(Height = Width x 50%)
Supplied half hard as standard.

Low Profile 33%
(Height = Width x 33%)
Supplied half hard as standard.

OW - Oval Wire

Available in 2 profiles:

Standard 55%
(Height = Width x 55%)
Supplied half hard as standard.

Low Profile 33%
(Height = Width x 33%)
Supplied half hard as standard.

SW - Square Wire

Drawn square. Supplied half hard as standard.

ST - Strip

Supplied half hard as standard.

SH - Sheet

Supplied fully annealed as standard.

CH - Chenier

Standard size is 30cm in length, shorter lengths also available. Supplied half hard as standard.

TAB - Solder Tab

Solder tabs are pre-cut pieces of solder sheet. They are repeatedly stamped with unique identifying marks. Solder tabs are available in 0.35mm and 0.20mm thickness.

LS - Solder Loose Sheet

Solder supplied in pieces of 0.35mm thickness sheet.

PST - Solder Paste

Solder Paste is supplied in a syringe applicator for easy and accurate placement of solder onto the workpiece.

Alloy Properties Definitions

FABRICATION ALLOYS, CASTING ALLOYS, MASTER ALLOYS AND SOLDERS

Alloy Code

Each alloy has its individual product code. When ordering a specific alloy, please use this code on your order or quote it to our Customer Service consultants.

Description / Application

The information contained in this column will describe the metal and help you identify which manufacturing process or application the alloy was designed for. They can be:

- Fabrication
- Casting applications
- Setting Alloy
- Laboratory
- Investment
- Alloying

Minimum Gold Content

The carat is most commonly expressed as fineness, or parts per thousand (750 = 18 carat, based on 24 carat being 1000).

Principle Elements

The main constituent elements of the alloy appear in this column. The following chemical symbols are used to identify these elements:

Au Gold	**Ag** Silver	**Pt** Platinum
Pd Palladium	**Cu** Copper	**Zn** Zinc
Ni Nickel	**Ru** Ruthenium	

Where Nickel is expressed in brackets as (Ni) in the 'Principle Elements' column, the Nickel content of the alloy is lesser than 1%.

Colour

We have described the colour of each alloy (as polished) to assist you with your selection, these descriptions however are intended to act only as a guide. In the case of white Golds we have applied the "White Gold Scale" which is described in more detail on page 149.

Liquidus Solidus

Liquidus refers to the temperature above which an alloy or metal is entirely molten. Solidus refers to the temperature below which an alloy or metal is completely solid. See Glossary for further definitions.

Melting Point

Melting is the process of heating a solid substance, in our case metal, to a point that it turns liquid. The point at which it turns liquid is the melting point for that metal or alloy.

Annealing Temperature

A temperature range is given for the effective annealing of hard worked metal. More detailed annealing procedures including visual cues are included in the 'Technical Information' section of this catalogue.

Quenching Technique

Fabrication Alloys

Kiln anneal for:

A 30 minutes, quench immediately
B 30 minutes, cool until slight red glow, quench
C 30 minutes, air cool on a steel plate
D 10 minutes, quench immediately
E 1 minute/mm of thickness, quench immediately

Please note that annealing temperatures relate directly to the alloy and annealing times relate to the mass of the piece or pieces to be annealed. As a consequence, some experimentation may be needed to arrive at the optimum annealing time or times for your individual requirements.

Quenching Technique

Casting Alloys

There are two methods for quenching your flask after casting. This column suggests a technique that will provide the best results for your castings.

1. Air cool for 20 - 25 minutes then quench in water. Most alloys once cast should be left for a minimum of 20 minutes to solidify. Once the metal is at this black heat stage the flask can be quenched in water to release the investment.
2. Quench immediately. For pink or rose Gold the alloy should be quenched as soon as the button has solidified, this may be a matter of a few minutes. If you allow the flask to cool slowly, which is the normal practice, the alloy will form an undesirable matrix as it solidifies. The result of this is that you may find the alloy becomes excessively brittle and your pieces crumble during clean up or further processing.

Hardness Vickers Hv

Hardness of the alloys is expressed in the Vickers hardness scale. This is a guide to the relative hardness of each alloy as determined by the resistance of the metal to indentation. The figures given in this column are for standard gauge products in their as supplied state or as cast for casting alloys.

All hardness testing has been conducted by external laboratories using either the Hv5 or the Hv10 scale.

As a guide:

Extra Soft	<75 Hv
Soft	75-99 Hv
Medium	100-124 Hv
Medium-Hard	125-150 Hv
Hard	>150 Hv

Density g/cm^3

Mass per unit volume expressed as per cubic centimetre of the alloy. This can be used to compare the weight of the same product in different alloys or even to identify one alloy from another.

Available Forms

Fabrication Alloys

The form in which each alloy can be purchased is listed by abbreviated letters (eg. GR = Granules) and can be matched to the quick reference icons. The sizes available are tabled on pages 37 to 46.

Available Forms

Solders

Solders are available in 4 forms:

Tab

Tabs are conveniently sized pre-cut pieces of sheet, 30mm x 15mm in size and are available in either 0.35mm or 0.20mm thickness. Each Tab is prestamped repeatedly with its unique alloy code (eg. 9YES = 9 carat Yellow Easy Solder) making identification easy, even when partially used.

0.50mm Round Wire

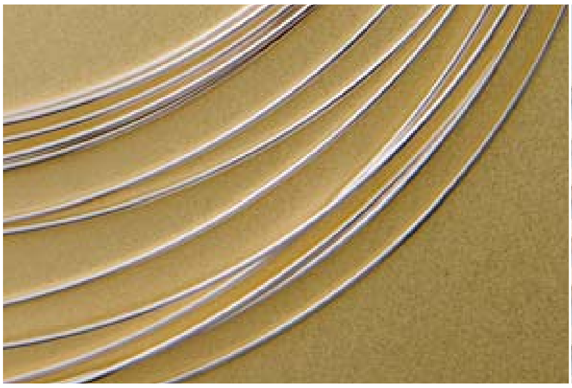
Most solders are also available in 0.50mm round wire form making them particularly good for working with chain soldering applications and large joint lengths.

Loose Sheet

Loose Sheet solders are supplied in a standard 0.35mm thickness, the advantage being that pieces may be cut to suit customer requirements. Loose Sheet solders are not carat or type stamped.

Paste

Solder Paste comes in a convenient easy to use syringe that enables you to accurately place the exact amount of solder you need in precisely the position you require it.



Casting Temperature*

We suggest that the metals should be cast 50°C to 100°C above the liquidus of the metal, however over heating of the metal should be avoided to minimise casting defects. If the product you are casting does not fully form or there is excessive crystallisation appearing on the surface of the metal we suggest that you try raising the temperature of the flask in the order of 15°C - 25°C increments until you see an improvement or deterioration in the quality. The flask temperature can be increased to a maximum of 50°C above the recommended temperature.

Flask Temperatures*

In the technical tables for the casting alloys we have included some guidelines for flask temperatures. These temperature ranges are not finite and will vary from one product to the next. You should use these as a starting point but must be prepared to try different temperatures in order to get the best results for your product. More detailed information on flask temperature is given by the investment supplier/manufacturer.

Flask Temp °C - Light*

These temperatures are to be used with pieces of lightweight construction, eg. thin filigree designs, these pieces would typically be only 2-6 grams.

Flask Temp °C - Heavy*

These temperatures are for pieces of heavy or solid construction, eg. solid signet rings. These pieces may typically weigh 20g or more and are often greater than 3mm thickness.

* The temperature & weights are provided as a guide only and are not intended to be definitive. All castings require the operator to observe and record the casting parameters that provide them with the optimum results.

Flow Rating

We have designed the solder ranges to provide you with maximum "wettability" and flow into the joint. The melting points or "flow rating" between consecutive solder alloys in a range (Easy, Medium, Hard etc.) are sufficiently spaced to allow you to achieve complex soldering constructions without risking damage to your previous work.

Cadmium Free

Cadmium has been used very successfully over the years as an addition when producing solders. Cadmium provides unmatched flow characteristics in the molten alloy and has become accepted by jewellers the world over. As Cadmium is a toxic heavy metal it is essential that Cadmium bearing solders only be used with adequate ventilation. This column clearly indicates which solders contain Cadmium as opposed to solders that are Cadmium free.

Flux

This column denotes if one of our solder products requires a flux coating while being soldered. Our range of fluxes can be found on page 57.

Required Carat

This is the carat, once alloyed, the Master was designed to produce.

GR SGW RW HR SW OW CH ST SH

Gold Fabrication Alloys

24 & 22 Carat Gold Fabrication Alloys

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus °C	Annealing Temp °C	Quenching Technique	Hardness Vickers HV	Density G/cm³	Available Forms
24Y	**Fine Gold**									
	Alloying, Laboratory, Investment	9996 9999	Au	Deep Yellow	1063 Melting Point	200	D	25	19.32	GR, SGW, RW, SH
22Y	**22ct Yellow**									
	Fabrication	917	Au, Ag, Cu, Zn	Royal Yellow	996-990	600	B	133	17.86	GR, SGW, RW, HR, SW, OW, SH
22P	**22ct Pink**									
	Fabrication	917	Au, Cu	Yellow Pink	946-915	600	A	138	17.63	GR, SGW

20 Carat Gold Fabrication Alloys

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus °C	Annealing Temp °C	Quenching Technique	Hardness Vickers HV	Density G/cm³	Available Forms
20Y	**20ct Yellow**									
	Fabrication	833	Au, Ag, Cu, Zn	Yellow	915-890	600-650	B	105	16.62	GR, SGW, SH
20P	**20ct Pink**									
	Fabrication	833	Au, Cu	Yellow Pink	925-901	600-650	A	136	16.37	SGW, SH

18 Carat Gold Fabrication Alloys

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus °C	Annealing Temp °C	Quenching Technique	Hardness Vickers HV	Density G/cm³	Available Forms
18Y	**18ct Yellow**									
	Fabrication, Casting	750	Au, Ag, Cu, Zn	Rich Yellow	905-880	550-600	B	144	15.51	GR, SGW, RW, HR, SW, OW, CH, SH, ST
18P	**18ct Pink**									
	Fabrication, Casting	750	Au, Ag, Pd, Cu	Yellow Pink	888-870	550-600	A	163	15.17	GR, SGW, RW, HR, SW, OW, CH, SH, ST
18W	**18ct White**									
	Fabrication	750	Au, Ag, Pd, Cu, Ni	Grey White YI 19	1050-1036	650-700	B	173	15.64	GR, SGW, RW, HR, SW, OW, SH, ST
18GP	**18ct White General Purpose**									
	Fabrication, Setting, Casting	750	Au, Ag, Pd, Cu, Zn, Ni	Grey White YI 17	1115-1103	650-700	B	151	15.90	SGW, RW, HR, SW, OW, CH, SH, ST
18WGF	**18ct White General Fabrication**									
	Fabrication, Setting, Casting	750	Au, Ag, Pd, Cu Zn, Ni	Grey White YI 14	1100-1020	650-700	B	148	15.79	SGW, RW, HR, SW, OW, SH, ST
18SA	**18ct White Setting Alloy**									
	Setting	750	Au, Ag, Pt, Pd	Grey White YI 19	1207-1190	650-700	B	136	17.39	SGW, RW, HR, SW, OW, SH, ST
18N	**18ct Nickel White**									
	High Tensile Fabrication	750	Au, Pd, Cu, Zn, Ni	White Grey YI 14	950-942	700-750	C	234	14.78	SGW, RW, HR, SW, SH, ST
18G	**18ct Green**									
	Fabrication	750	Au, Ag, Cu, Cd	Yellow Green	887-861	550-600	B	130	15.53	SGW, SH

15 Carat Gold Fabrication Alloys

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus ºC	Annealing Temp ºC	Quenching Technique	Hardness Vickers HV	Density G/cm³	Available Forms
15Y	**15ct Yellow**									
	Fabrication	625	Au, Ag, Cu, Zn	Yellow	843-833	650	B	140	13.53	GR, SGW, RW, SH
15P	**15ct Pink**									
	Fabrication	625	Au, Ag, Cu, Zn	Pink	885-853	650	A	135	13.50	GR, SGW, RW, SH

14 Carat Gold Fabrication Alloys

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus ºC	Annealing Temp ºC	Quenching Technique	Hardness Vickers HV	Density G/cm³	Available Forms
14Y	**14ct Yellow**									
	Fabrication, Casting	585	Au, Ag, Cu, Zn	Yellow	862-853	650	B	141	12.96	GR, SGW, RW, HR, OW, SH, ST
14P	**14ct Pink**									
	Fabrication, Casting	585	Au, Ag, Cu, Zn	Pink	889-875	650	A	150	13.09	GR, SGW, RW, SH, ST
14W	**14ct White**									
	Fabrication, Casting	585	Au, Ag, Pd, Cu, Ni	Grey White YI 17	1002-970	650-700	B	193	13.87	GR, SGW, RW, SH, ST

10 Carat Gold Fabrication Alloys

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus ºC	Annealing Temp ºC	Quenching Technique	Hardness Vickers HV	Density G/cm³	Available Forms
10Y	**10ct Yellow**									
	Fabrication, Casting	417	Au, Ag, Cu, Zn	Warm Yellow	869-850	650	B	130	11.48	GR, SGW, RW, SH
10W	**10ct White**									
	Fabrication	417	Au, Ag, Pd, Zn	White YI 14	986-965	650-700	B	98	12.84	GR, SGW, RW, SH

9 Carat Gold Fabrication Alloys

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus ºC	Annealing Temp ºC	Quenching Technique	Hardness Vickers HV	Density G/cm³	Available Forms
9Y	**9ct Yellow**									
	Fabrication, Casting	375	Au, Ag, Cu, Zn	Warm Yellow	899-851	650	B	140	11.16	GR, SGW, RW, HR, SW, OW, CH, SH, ST
9P	**9ct Pink**									
	Fabrication, Casting	375	Au, Ag, Cu, Zn	Pink Red	958-944	650	A	111	11.23	GR, SGW, RW, HR, SW, OW, CH, SH, ST
9W	**9ct White**									
	Fabrication, Casting	375	Au, Ag, Pd, Zn	White YI 14	971-948	650-700	B	95	12.55	GR, SGW, RW, HR, SW, OW, SH, ST
9GP	**9ct White General Purpose**									
	Fabrication, Setting, Casting	375	Au, Ag, Pd, Cu, (Ni)	Grey White YI 19	1115-1097	650-700	B	114	12.79	SGW, RW, HR, SW, OW, CH, SH, ST
9SA	**9ct White Setting Alloy**									
	Setting	375	Au, Ag, Pt, Pd, (Ni)	Grey White YI 17	1130-1108	650-700	B	160	13.38	SGW, RW, SW, SH, ST
9N	**9ct Nickel White**									
	High Tensile Fabrication	375	Au, Cu, Zn, Ni	White YI 14	1085-1040	700-750	C	200	10.94	SGW, RW, SW, SH, ST

WHERE NICKEL IS EXPRESSED BRACKETED (Ni) IN THE "PRINCIPLE ELEMENTS" COLUMN, THE NICKEL CONTENT OF THE ALLOY IS LESSER THAN 1%.

Gold Setting Alloys & Silver Fabrication Alloys

Gold Setting Alloys

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus ⁰C	Annealing Temp ⁰C	Quenching Technique	Hardness Vickers HV	Density G/cm³	Available Forms
18SA	**18ct White Setting Alloy**									
	Setting	750	Au, Ag, Pt, Pd	Grey White YI 19	1207-1190	650-700	B	136	17.39	SGW, RW, HR, SW, SH, ST
9SA	**9ct White Setting Alloy**									
	Setting	375	Au, Ag, Pt, Pd, (Ni)	Grey White YI 17	1130-1108	650-700	B	160	13.38	SGW, RW, HR, SW, SH, ST
BSA	**9.6ct White Setting Alloy**									
	Setting	400	Au, Ag, Pt, Pd, (Ni)	Grey White YI 14	1141-1120	650-700	B	165	13.63	SGW, RW, SH

WHERE NICKEL IS EXPRESSED BRACKETED (Ni) IN THE "PRINCIPLE ELEMENTS" COLUMN, THE NICKEL CONTENT OF THE ALLOY IS LESSER THAN 1%.

Silver Fabrication Alloys

Code	Description Application	Min. Silver Content	Principle Elements	Colour	Liquidus Solidus ⁰C	Annealing Temp ⁰C	Quenching Technique	Hardness Vickers HV	Density G/cm³	Available Forms
FS	**Fine Silver**									
	Alloying, Investment	999+	Ag	White	961 Melting Point	400	D	25	10.49	GR, SGW, RW, SH
SS	**Sterling Silver**									
	Fabrication, Casting	925	Ag, Cu	White	900-878	650	B	75	10.36	GR, SGW, RW, HR, SW, OW, CH, SH
925AG	**Oxide Resistant Silver**									
	Fabrication, Casting	925	Ag, Cu, Zn	White	899-778	700	A	68	10.30	GR, SGW, RW, HR, SW, OW, SH

Fine Metals, Platinum & Palladium Fabrication Alloys

Fine Metals

Code	Description Application	Minimum Fine Metal Content	Principle Elements	Colour	Melting Point °C	Annealing Temp °C	Quenching Technique	Hardness Vickers HV	Density G/cm³	Available Forms
24Y	**Fine Gold**									
	Alloying, Laboratory, Investment	9996 9999	Au	Deep Yellow	1063	200	D	25	19.32	GR, SGW, RW, SH
FS	**Fine Silver**									
	Alloying, Investment	999+	Ag	White	961	400	D	25	10.49	GR, SGW, RW, SH
PLAT	**Pure Platinum**									
	Alloying, Investment	9999	Pt	White	1769	1000	E	37	21.45	GR
PALL	**Pure Palladium**									
	Alloying, Investment	9999	Pd	White	1552	875	E	37	12.00	GR

Platinum Fabrication Alloys

Code	Description Application	Minimum Platinum Content	Principle Elements	Colour	Liquidus Solidus °C	Annealing Temp °C	Quenching Technique	Hardness Vickers HV	Density G/cm³	Available Forms
PT970	**97% Platinum/Copper**									
	Fabrication, Casting	970	Pt, Cu	White	1755-1740	1000	E	130	20.59	SGW
PT960	**96% Platinum/Copper**									
	Fabrication, Casting	960	Pt, Cu	White	1745-1725	1000	E	132	20.32	SGW
PT950RU	**95% Platinum/Ruthenium**									
	Fabrication, Casting	950	Pt, Ru	White	1790-1780	1000	E	160	20.70	SGW

Palladium Fabrication Alloy

Code	Description Application	Minimum Palladium Content	Principle Elements	Colour	Liquidus Solidus °C	Annealing Temp °C	Quenching Technique	Hardness Vickers HV	Density G/cm³	Available Forms
PD950AG	**95% Palladium/Silver**									
	Fabrication, Casting	950	Pd, Ag	White	1450-1380	750	E	140	11.80	SGW

Casting Alloys

Peter W Beck Precious Metal Services®

Toll Free 1800 888 590
Telephone 08 8440 3399
Facsimile 08 8447 1144
Email preciousmetals@pwbeck.com.au
Web www.pwbeck.com.au

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GR

Gold Casting Alloys

22 Carat Gold Casting Alloy

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus ⁰C	Flask Temp ⁰C Light*	Flask Temp ⁰C Heavy*	Quenching Technique	Density G/cm³
22YC	**22ct Yellow Casting**								
	Casting, Fabrication	917	Au, Ag, Cu, Zn	Royal Yellow	996-990	600	400	1	17.86

18 Carat Gold Casting Alloys

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus ⁰C	Flask Temp ⁰C Light*	Flask Temp ⁰C Heavy*	Quenching Technique	Density G/cm³
18YC	**18ct Yellow Casting**								
	Casting, Fabrication	750	Au, Ag, Cu, Zn	Rich Yellow	905-880	650-550	450-300	1	15.51
18PC	**18ct Pink Casting**								
	Casting, Fabrication	750	Au, Ag, Pd, Cu	Yellow Pink	888-870	650-550	450-300	2	15.17
18WGC	**18ct White General Casting**								
	Casting, Fabrication, Setting	750	Au, Ag, Pd, Cu, Zn	Grey White YI 17	1090-960	650-600	500-400	1	16.05
18W2C	**18ct White Casting**								
	Casting	750	Au, Ag, Pd Cu, Zn	Grey White YI 31	1062-1031	650-600	500-400	1	15.65

14 Carat Gold Casting Alloys

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus ⁰C	Flask Temp ⁰C Light*	Flask Temp ⁰C Heavy*	Quenching Technique	Density G/cm³
14YC	**14ct Yellow Casting**								
	Casting, Fabrication	585	Au, Ag, Cu, Zn	Yellow	862-853	650-550	450-300	1	12.96
14PC	**14ct Pink Casting**								
	Casting, Fabrication	585	Au, Ag, Cu, Zn	Pink	889-875	600-500	400-300	2	13.09
14WC	**14ct White Casting**								
	Casting, Fabrication	585	Au, Ag, Pd, Cu, Zn (Ni)	Grey White YI 19	1011-999	650-600	500-400	1	14.19

WHERE NICKEL IS EXPRESSED BRACKETED (Ni) IN THE "PRINCIPLE ELEMENTS" COLUMN, THE NICKEL CONTENT OF THE ALLOY IS LESSER THAN 1%.

10 Carat Gold Casting Alloy

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus ⁰C	Flask Temp ⁰C Light*	Flask Temp ⁰C Heavy*	Quenching Technique	Density G/cm³
10YC	**10ct Yellow Casting**								
	Casting, Fabrication	417	Au, Ag, Cu, Zn	Warm Yellow	869-850	650-550	450-300	1	11.48

* THE FLASK TEMPERATURES ARE PROVIDED AS A GUIDE ONLY AND ARE NOT INTENDED TO BE DEFINITIVE. ALL CASTINGS REQUIRE THE OPERATOR TO OBSERVE AND RECORD THE CASTING PARAMETERS THAT PROVIDE THEM WITH THE OPTIMUM RESULTS.

Gold, Silver, Platinum & Palladium Casting Alloys

9 Carat Gold Casting Alloys

Code	Description Application	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus ⁰C	Flask Temp ⁰C Light*	Flask Temp ⁰C Heavy*	Quenching Technique	Density G/cm³
9YC	**9ct Yellow Casting**								
	Casting, Fabrication	375	Au, Ag, Cu, Zn	Warm Yellow	899-851	600-500	400-300	1	11.16
9PC	**9ct Pink Casting**								
	Casting, Fabrication	375	Au, Ag, Cu, Zn	Pink Red	958-944	600-500	400-300	2	11.23
9WC	**9ct White Casting**								
	Casting, Fabrication	375	Au, Ag, Pd, Zn	White YI 14	971-948	650-600	500-350	1	12.55

Silver Casting Alloy

Code	Description Application	Min. Silver Content	Principle Elements	Colour	Liquidus Solidus ⁰C	Flask Temp ⁰C Light*	Flask Temp ⁰C Heavy*	Quenching Technique	Density G/cm³
925AG1C	**Oxide Resistant Silver Casting**								
	Casting, Fabrication	925	Ag, Cu, Zn	White	899-778	600-500	400-300	2	10.30

Platinum Casting Alloys

Code	Description Application	Min. Platinum Content	Principle Elements	Colour	Liquidus Solidus ⁰C	Flask Temp ⁰C Light*	Flask Temp ⁰C Heavy*	Quenching Technique	Density G/cm³
PT9501C	**95% Platinum/Palladium Casting**								
	Casting	950	Pt, Pd	White	1650 Melting Point	800	800	2	19.76
PT950RUC	**95% Platinum/Ruthenium Casting**								
	Casting, Fabrication	950	Pt, Ru	White	1790-1780	900	900	2	20.70

Palladium Casting Alloy

Code	Description Application	Min. Palladium Content	Principle Elements	Colour	Liquidus Solidus ⁰C	Flask Temp ⁰C Light*	Flask Temp ⁰C Heavy*	Quenching Technique	Density G/cm³
PD950AGC	**95% Palladium/Silver Casting**								
	Casting, Fabrication	950	Pd, Ag	White	1450-1380	800	800	2	11.80

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Solders

Peter W Beck Precious Metal Services®

Toll Free 1800 888 590
Telephone 08 8440 3399
Facsimile 08 8447 1144
Email preciousmetals@pwbeck.com.au
Web www.pwbeck.com.au

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TAB RW LS

Gold, Silver & Platinum Solders

22 Carat Gold Solder

Code	Description	Min. Gold Content	Colour	Cadmium Free	Liquidus Solidus °C	Density G/cm^3	Available Forms	Flux
22YMS	22ct Yellow Medium	917	Yellow	No	926 - 900	17.34	SH	Yes
22YHS	22ct Yellow Very Hard	917	Yellow	No	955 - 938	17.48	SH	Yes

18 Carat Gold Solder

Code	Description	Min. Gold Content	Colour	Cadmium Free	Liquidus Solidus °C	Density G/cm^3	Available Forms	Flux
18YES	18ct Yellow Easy	750	Yellow	No	710 - 690	14.66	TAB, RW	Yes
18YMS	18ct Yellow Medium	750	Yellow	No	785 - 760	14.70	TAB, RW	Yes
18YMHS	18ct Yellow Medium Hard	750	Yellow	Yes	804 - 795	14.81	TAB, RW	Yes
18YHS	18ct Yellow Hard	750	Yellow	No	841 - 830	15.15	TAB, RW	Yes
18WES	18ct White Easy	750	White	Yes	835 - 799	14.16	TAB	Yes
18WHS	18ct White Hard	750	White	Yes	892 - 871	14.54	TAB	Yes

14 Carat Gold Solder

Code	Description	Min. Gold Content	Colour	Cadmium Free	Liquidus Solidus °C	Density G/cm^3	Available Forms	Flux
14YES	14ct Yellow Easy	585	Yellow	Yes	730 - 720	12.77	TAB	Yes
14YHS	14ct Yellow Hard	585	Yellow	Yes	802 - 785	13.43	TAB	Yes

9 Carat Gold Solder

Code	Description	Min. Gold Content	Colour	Cadmium Free	Liquidus Solidus °C	Density G/cm^3	Available Forms	Flux
9YXES	9ct Yellow Extra Easy	375	Yellow	No	653 - 645	11.52	TAB, RW	Yes
9YES	9ct Yellow Easy	375	Yellow	No	715 - 706	11.73	TAB, RW	Yes
9YMS	9ct Yellow Medium	375	Yellow	No	759 - 745	11.90	TAB, RW	Yes
9YHS	9ct Yellow Hard	375	Yellow	Yes	792 - 799	11.68	TAB, RW	Yes
9WES	9ct White Easy	375	White	Yes	735 - 720	11.68	TAB	Yes
9WHS	9ct White Hard	375	White	Yes	802 - 783	11.97	TAB	Yes

Uncarated Gold Solder

Code	Description	Min. Gold Content	Colour	Cadmium Free	Liquidus Solidus °C	Density G/cm³	Available Forms	Flux
78PMS	7.8ct Pink Medium	327	Pink	No	767 - 743	10.91	TAB	Yes
120WES	12ct White Easy	500	White	Yes	695 - 683	12.14	TAB	Yes
138WMS	13.8ct White Medium	578	White	Yes	752 - 745	13.10	TAB	Yes
200WHS	20ct White Hard	833	White	Yes	874 - 861	15.69	TAB	Yes

Silver Solder

Code	Description	Min. Silver Content	Colour	Cadmium Free	Liquidus Solidus °C	Density G/cm³	Available Forms	Flux
SSXES	Stg Silver Extra Easy	500	White	No	643 - 631	9.21	TAB, RW	Yes
SSES	Stg Silver Easy	600	White	Yes	706 - 702	9.43	TAB, RW	Yes
SSMS	Stg Silver Medium	700	White	Yes	732 - 720	9.70	TAB, RW	Yes
SSHS	Stg Silver Hard	760	White	Yes	778 - 767	9.99	TAB, RW	Yes

Platinum Solder

Code	Description	Colour	Cadmium Free	Working Temp °C	Density G/cm³	Available Forms	Flux
PTES	Easy Solder for Platinum	White	Yes	1100	12.89	LS	No
PTMS	Medium Solder for Platinum	White	Yes	1250	14.14	LS	No
PTHS	Hard Solder for Platinum	White	Yes	1390	15.69	LS	No

PST

Gold & Silver Solder Paste

A HOMOGENISED MIXTURE OF CARATED GOLD AND SILVER IN THE FORM OF VERY FINE POWDER COMBINED WITH A LIQUID BINDING AGENT AND FLUX. A SYRINGE APPLICATOR IS USED TO DISPENSE THE PASTE WHICH ALLOWS FOR VERY ACCURATE SOLDER PLACEMENT AND CONTROLLED AMOUNTS.

18 Carat Solder Paste

Code	Description	Min. Gold Content	Colour	Cadmium Free	Working Temp °C	Available Forms	Flux
18YES	18ct Yellow Easy	750	Yellow	Yes	630	PST	No
18YMS	18ct Yellow Medium	750	Yellow	Yes	735	PST	No
18YHS	18ct Yellow Hard	750	Yellow	Yes	763	PST	No
18PES	18ct Pink Easy	750	Pink	Yes	710	PST	No
18PMS	18ct Pink Medium	750	Pink	Yes	770	PST	No
18WES	18ct White Easy	750	White	Yes	770	PST	No
18WHS	18ct White Hard	750	White	No	855	PST	No

9 Carat Solder Paste

Code	Description	Min. Gold Content	Colour	Cadmium Free	Working Temp °C	Available Forms	Flux
9YES	9ct Yellow Easy	375	Yellow	Yes	680	PST	No
9YMS	9ct Yellow Medium	375	Yellow	Yes	720	PST	No
9YHS	9ct Yellow Hard	375	Yellow	Yes	742	PST	No
9PES	9ct Pink Easy	375	Pink	No	770	PST	No
9WMS	9ct White Medium	375	White	Yes	710	PST	No

Silver Solder Paste

Code	Description	Min. Silver Content	Colour	Cadmium Free	Working Temp °C	Available Forms	Flux
SSXES	Stg Silver Extra Easy	800	White	Yes	650	PST	No
SSES	Stg Silver Easy	925	White	Yes	690	PST	No
SSMS	Stg Silver Medium	925	White	Yes	730	PST	No
SSHS	Stg Silver Hard	925	White	Yes	770	PST	No

Master Alloys

Peter W Beck Precious Metal Services®

Toll Free	1800 888 590
Telephone	08 8440 3399
Facsimile	08 8447 1144
Email	preciousmetals@pwbeck.com.au
Web	www.pwbeck.com.au

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GR

Master Alloys

When alloying, it is critical that the Fine Metal and Master Alloy are accurately weighed and combined in the specific ratio for that carat. We have included with each table a Suggested Alloy Composition guide to ensure you accurately carat your alloys.

Note: The Suggested Alloy Composition assumes the fine metal content is alloyed to an additional .002 fineness in order to ensure alloy carat integrity.

Eg. 18ct = 752 parts per 1000 or 75.2% & 9ct = 377 parts per 1000 or 37.7%.

Under each carat section you will find suggested precious metal and master alloy percentages which you will find helpful if you follow the alloying principles below.

Alloying example:

If you require 30gms of 18ct Yellow

1. 30gms x 75.2% = 22.56gms (amount of Fine Gold to use)
2. 30gms x 24.8% = 7.44gms (amount of 18YM master alloy to use)
3. Check figures: 22.56gms (Fine Gold) + 7.44gms (master alloy) = 30gms (total of 18y required)

Gold Fabrication Master Alloys

22 Carat Fabrication Master Alloy

Code	Description	Principle Elements	Required Carat	Colour Final Alloy	Liquidus Solidus °C Master Alloy	Density G/cm³ Final Alloy
22YM	22ct Yellow Fabrication Master	Ag, Cu, Zn	22ct	Royal Yellow	820 - 797	17.86

SUGGESTED ALLOY COMPOSITION: (WEIGHT REQUIRED x 91.8% = FINE GOLD) + (WEIGHT REQUIRED x 8.2% = MASTER ALLOY) = TOTAL 22 CARAT WEIGHT REQUIRED

18 Carat Fabrication Master Alloys

Code	Description	Principle Elements	Required Carat	Colour Final Alloy	Liquidus Solidus °C Master Alloy	Density G/cm³ Final Alloy
18YM	18ct Yellow Fabrication Master	Ag, Cu, Zn	18ct	Rich Yellow	816 - 790	15.51
18PM	18ct Pink Fabrication Master	Ag, Pd, Cu	18ct	Yellow Pink	960 - 945	15.17
18GPM	18ct White General Purpose Fabrication Master	Ag, Pd, Cu, Zn, Ni	18ct	Grey White	1097 - 1083	15.90
18WM	18ct White Fabrication Master	Ag, Pd, Cu, Zn	18ct	Grey White	1110 - 1085	15.64

SUGGESTED ALLOY COMPOSITION: (WEIGHT REQUIRED x 75.2% = FINE GOLD) + (WEIGHT REQUIRED x 24.8% = MASTER ALLOY) = TOTAL 18 CARAT WEIGHT REQUIRED

Gold & Silver Fabrication Master Alloys

14 Carat Fabrication Master Alloys

Code	Description	Principle Elements	Required Carat	Colour Final Alloy	Liquidus Solidus °C Master Alloy	Density G/cm³ Final Alloy
14YM	14ct Yellow Fabrication Master	Ag, Cu, Zn	14ct	Yellow	910 - 892	12.96
14PM	14ct Pink Fabrication Master	Ag, Cu, Zn	14ct	Pink	1028 - 980	13.09
14WM	14ct White Fabrication Master	Ag, Pd, Cu, Ni	14ct	Grey White	1110 - 1085	13.87

SUGGESTED ALLOY COMPOSITION: (WEIGHT REQUIRED x 58.7% = FINE GOLD) + (WEIGHT REQUIRED x 41.3% = MASTER ALLOY) = TOTAL 14 CARAT WEIGHT REQUIRED

9 Carat Fabrication Master Alloys

Code	Description	Principle Elements	Required Carat	Colour Final Alloy	Liquidus Solidus °C Master Alloy	Density G/cm³ Final Alloy
9YM	9ct Yellow Fabrication Master	Ag, Cu, Zn	9ct	Warm Yellow	931 - 907	11.16
9PM	9ct Pink Fabrication Master	Ag, Cu, Zn	9ct	Pink	982 - 959	11.23
9GPM	9ct White General Purpose Fabrication Master	Ag, Pd, Cu, Zn, (Ni)	9ct	Grey White	1031 - 1020	12.79
9WM	9ct White Fabrication Master	Ag, Pd, Zn	9ct	White	916 - 895	12.55

SUGGESTED ALLOY COMPOSITION: (WEIGHT REQUIRED x 37.7% = FINE GOLD) + (WEIGHT REQUIRED x 62.3% = MASTER ALLOY) = TOTAL 9 CARAT WEIGHT REQUIRED

WHERE NICKEL IS EXPRESSED BRACKETED (Ni) IN THE "PRINCIPLE ELEMENTS" COLUMN, THE NICKEL CONTENT OF THE ALLOY IS LESSER THAN 1% WHEN ALLOYED WITH FINE GOLD

925 Silver Fabrication Master Alloy

Code	Description	Principle Elements	Colour Final Alloy	Liquidus Solidus °C Master Alloy	Density G/cm³ Final Alloy
925AGM	Oxide Resistant Silver Fabrication Master	Cu, Zn	White	1070 - 1035	10.30

SUGGESTED ALLOY COMPOSITION: (WEIGHT REQUIRED x 92.7% = FINE SILVER) + (WEIGHT REQUIRED x 7.3% = MASTER ALLOY) = TOTAL 925 SILVER WEIGHT REQUIRED

Gold Casting Master Alloys

22 Carat Casting Master Alloy

Code	Description	Principle Elements	Required Carat	Colour Final Alloy	Liquidus Solidus °C Master Alloy	Flask Temp °C Light *	Flask Temp °C Heavy *	Density G/cm³ Final Alloy
22YCM	22ct Yellow Casting Master	Ag, Cu, Zn	22ct	Royal Yellow	820 - 797	600	400	17.86

SUGGESTED ALLOY COMPOSITION: (WEIGHT REQUIRED x 91.8% = FINE GOLD) + (WEIGHT REQUIRED x 8.2% = MASTER ALLOY) = TOTAL 22 CARAT WEIGHT REQUIRED

18 Carat Casting Master Alloys

Code	Description	Principle Elements	Required Carat	Colour Final Alloy	Liquidus Solidus °C Master Alloy	Flask Temp °C Light *	Flask Temp °C Heavy *	Density G/cm³ Final Alloy
18YCM	18ct Yellow Casting Master	Ag, Cu, Zn	18ct	Rich Yellow	816 - 790	650 - 550	450 - 300	15.40
18PCM	18ct Pink Casting Master	Ag, Cu, Zn	18ct	Yellow Pink	1025 - 1005	650 - 550	450 - 300	15.19
18W2CM	18ct White Casting Master	Ag, Pd, Cu, Ni	18ct	Grey White	1097 - 1010	650 - 600	500 - 400	15.70

SUGGESTED ALLOY COMPOSITION: (WEIGHT REQUIRED x 75.2% = FINE GOLD) + (WEIGHT REQUIRED x 24.8% = MASTER ALLOY) = TOTAL 18 CARAT WEIGHT REQUIRED

14 Carat Casting Master Alloys

Code	Description	Principle Elements	Required Carat	Colour Final Alloy	Liquidus Solidus °C Master Alloy	Flask Temp °C Light *	Flask Temp °C Heavy *	Density G/cm³ Final Alloy
14YCM	14ct Yellow Casting Master	Ag, Cu, Zn	14ct	Yellow	910 - 892	650 - 550	450 - 300	12.96
14PCM	14ct Pink Casting Master	Ag, Cu, Zn	14ct	Pink	1028 - 980	650 - 550	450 - 300	13.09
14WCM	14ct White Casting Master	Ag, Pd, Cu, An, (Ni)	14ct	Grey White	1030 - 960	650 - 600	500 - 400	14.19

SUGGESTED ALLOY COMPOSITION: (WEIGHT REQUIRED x 58.7% = FINE GOLD) + (WEIGHT REQUIRED x 41.3% = MASTER ALLOY) = TOTAL 14 CARAT WEIGHT REQUIRED

WHERE NICKEL IS EXPRESSED BRACKETED (Ni) IN THE "PRINCIPLE ELEMENTS" COLUMN, THE NICKEL CONTENT OF THE ALLOY IS LESSER THAN 1% WHEN ALLOYED WITH FINE GOLD

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Gold & Silver Casting Master Alloys

9 Carat Casting Master Alloys

Code	Description	Principle Elements	Required Carat	Colour Final Alloy	Liquidus Solidus °C Master Alloy	Flask Temp °C Light *	Flask Temp °C Heavy *	Density G/cm^3 Final Alloy
9YCM	9ct Yellow Casting Master	Ag, Cu, Zn	9ct	Warm Yellow	931 - 907	600 - 500	400 - 300	11.15
9PCM	9ct Pink Casting Master	Ag, Cu, Zn	9ct	Pink Red	982 - 959	600 - 500	400 - 300	11.23
9WCM	9ct White Casting Master	Ag, Pd, Zn	9ct	White	916 - 895	650 - 600	500 - 350	12.56

SUGGESTED ALLOY COMPOSITION: (WEIGHT REQUIRED x 37.7% = FINE GOLD) + (WEIGHT REQUIRED x 62.3% = MASTER ALLOY) = TOTAL 9 CARAT WEIGHT REQUIRED

925 Silver Casting Master Alloy

Code	Description	Principle Elements	Colour Final Alloy	Liquidus Solidus °C Master Alloy	Flask Temp °C Light *	Flask Temp °C Heavy *	Density G/cm^3 Final Alloy
925AG1CM	Oxide Resistant Silver Casting Master	Cu, Zn	White	1070 - 1035	600 - 500	400 - 300	10.30

SUGGESTED ALLOY COMPOSITION: (WEIGHT REQUIRED x 92.7% = FINE SILVER) + (WEIGHT REQUIRED x 7.3% = MASTER ALLOY) = TOTAL 925 SILVER WEIGHT REQUIRED

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Available Forms

Peter W Beck Precious Metal Services®

Toll Free 1800 888 590
Telephone 08 8440 3399
Facsimile 08 8447 1144
Email preciousmetals@pwbeck.com.au
Web www.pwbeck.com.au

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Using the Size & Weight Tables

Included in this section are approximate weight tables for the most common fabrication alloys referenced against the available sizes and profiles.

Using the information given, 18ct Yellow, 18ct White, 9ct Yellow, 9ct White and Sterling Silver weights and lengths of the product can be easily calculated. From these weights you can convert to another carat by either using the carat weight conversion table on page 152, or by comparing the density (g/cm^3) of the various alloys.

Example calculations:

(a) Determine the weight of 10cm of **6.25mm** 18ct Yellow round wire

Calculation: 10 x **4.76** = 47.6 grams

(b) How long would 50gms of **6.25mm** 18ct Yellow round wire be?

Calculation: 50gms ÷ **4.76** = 10.5cm.

RW

RW Round Wire

Diameter (mm)	9Y	9W	18Y	18W	SS
7.00	4.29	4.83	5.97	6.02	3.99
6.75	3.99	4.49	5.55	5.60	3.71
6.50	3.70	4.16	5.15	5.19	3.44
6.25	3.42	3.85	**4.76**	4.80	3.18
6.00	3.16	3.55	4.39	4.42	2.93
5.75	2.90	3.26	4.03	4.06	2.69
5.50	2.65	2.98	3.68	3.39	2.24
5.25	2.42	2.72	3.36	3.39	2.24

Size & Weight Table

SGW Standard Gauge Wire

SGW

• APPROXIMATE WEIGHT PER CM • SUPPLIED FULLY ANNEALED
• AVAILABLE AS 4.5mm or 6.0mm SQUARE WIRE

Code	Description/ Colour	4.5mm Square	6.0mm Square
22Y	22ct Yellow Gold	3.48	5.98
22P	22ct Pink Gold	3.43	5.90
20Y	20ct Yellow Gold	3.24	5.57
18Y	18ct Yellow Gold	3.02	5.19
18P	18ct Pink Gold	2.95	5.07
18W	18ct White Gold	3.05	5.13
18GP	18ct White General Purpose Gold	3.10	5.33
18WGF	18ct White General Fabrication Gold	3.19	5.68
18N	18ct Nickel White Gold	2.87	4.93
18G	18ct Green Gold	3.02	5.19
18SA	18ct White Setting Alloy	3.38	5.81
15Y	15ct Yellow Gold	2.62	4.50
15P	15ct Pink Gold	2.61	4.49
14Y	14ct Yellow Gold	2.52	4.33
14P	14ct Pink Gold	2.54	4.37
14W	14ct White Gold	3.26	5.61
10Y	10ct Yellow Gold	2.23	3.83
10W	10ct White Gold	2.50	4.30
9Y	9ct Yellow Gold	2.17	3.74
9P	9ct Pink Gold	2.18	3.75
9W	9ct White Gold	2.45	4.21
9GP	9ct White General Purpose Gold	2.49	4.28
9N	9ct Nickel White Gold	2.27	3.90
9SA	9ct White Setting Alloy	2.61	4.49
BSA	White Setting Alloy	2.65	4.56
PT950RU	95% Platinum Ruthenium Alloy	3.90	7.11
PT960	96% Platinum Copper Alloy	3.82	6.97
PT970	97% Platinum Copper Alloy	3.88	7.06
PD950AG	95% Palladium Silver Alloy	2.39	4.25
FS	Fine Silver	2.04	3.51
SS	Sterling Silver	2.02	3.47
925AG	92.5% Oxide Resistant Silver	2.01	3.46

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Size & Weight Table

RW Round Wire

RW

- APPROXIMATE WEIGHT PER CM
- WIRES ARE SUPPLIED HALF HARD UNLESS SPECIFIED

Diameter (mm)	9Y	9W	18Y	18W	SS
7.00	4.29	4.83	5.97	6.02	3.99
6.75	3.99	4.49	5.55	5.60	3.71
6.50	3.70	4.16	5.15	5.19	3.44
6.25	3.42	3.85	4.76	4.80	3.18
6.00	3.16	3.55	4.39	4.42	2.93
5.75	2.90	3.26	4.03	4.06	2.69
5.50	2.65	2.98	3.68	3.72	2.46
5.25	2.42	2.72	3.36	3.39	2.24
5.00	2.19	2.46	3.05	3.07	2.03
4.75	1.98	2.22	2.75	2.77	1.84
4.50	1.77	2.00	2.47	2.49	1.65
4.25	1.58	1.78	2.20	2.22	1.47
4.00	1.40	1.58	1.95	1.97	1.30
3.90	1.33	1.50	1.85	1.87	1.24
3.80	1.27	1.42	1.76	1.77	1.17
3.75	1.23	1.39	1.71	1.73	1.14
3.70	1.20	1.35	1.67	1.68	1.11
3.60	1.14	1.28	1.58	1.59	1.05
3.50	1.07	1.21	1.49	1.50	1.00
3.40	1.01	1.14	1.41	1.42	0.94
3.30	0.95	1.07	1.33	1.34	0.89
3.25	0.93	1.04	1.29	1.30	0.86
3.20	0.90	1.01	1.25	1.26	0.83
3.10	0.84	0.95	1.17	1.18	0.78
3.00	0.79	0.89	1.10	1.11	0.73
2.90	0.72	0.83	1.02	1.03	0.68
2.80	0.69	0.77	0.96	0.96	0.64
2.75	0.66	0.75	0.92	0.93	0.62
2.70	0.64	0.72	0.89	0.90	0.59
2.60	0.59	0.67	0.82	0.83	0.55
2.50	0.55	0.62	0.76	0.77	0.51
2.40	0.50	0.57	0.70	0.71	0.47
2.30	0.46	0.52	0.64	0.65	0.43
2.25	0.44	0.50	0.62	0.62	0.41
2.20	0.42	0.48	0.59	0.59	0.39

Diameter (mm)	9Y	9W	18Y	18W	SS
2.10	0.39	0.43	0.54	0.54	0.36
2.00	0.35	0.39	0.49	0.49	0.33
1.90	0.32	0.36	0.44	0.44	0.29
1.80	0.28	0.32	0.39	0.40	0.26
1.75	0.27	0.30	0.37	0.38	0.25
1.70	0.25	0.28	0.35	0.35	0.24
1.60	0.22	0.25	0.31	0.31	0.21
1.50	0.20	0.22	0.27	0.28	0.18
1.40	0.17	0.19	0.24	0.24	0.16
1.30	0.15	0.17	0.21	0.21	0.14
1.25	0.14	0.15	0.19	0.19	0.13
1.20	0.13	0.14	0.18	0.18	0.12
1.15	0.12	0.13	0.16	0.16	0.11
1.10	0.11	0.12	0.15	0.15	0.10
1.00	0.088	0.099	0.122	0.123	0.081
0.95	0.079	0.089	0.110	0.111	0.073
0.90	0.071	0.080	0.099	0.099	0.066
0.85	0.063	0.071	0.088	0.089	0.059
0.80	0.056	0.063	0.078	0.079	0.052
0.75	0.049	0.055	0.069	0.069	0.046
0.70	0.043	0.048	0.060	0.060	0.040
0.65	0.037	0.042	0.051	0.052	0.034
0.60	0.032	0.035	0.044	0.044	0.029
0.55	0.027	0.030	0.037	0.037	0.025
0.525	0.024	0.027	0.034	0.034	0.022
0.500	0.022	0.025	0.030	0.031	0.020
0.475	0.020	0.022	0.027	0.028	0.018
0.450	0.016	0.020	0.025	0.025	0.016
0.425	0.015	0.018	0.022	0.022	0.015
0.400	0.014	0.016	0.019	0.020	0.013
0.375	0.012	0.014	0.017	0.017	0.011
0.350	0.011	0.012	0.015	0.015	0.010
0.325	0.009	0.010	0.013	0.013	0.009
0.300	0.008	0.009	0.011	0.011	0.007

Size & Weight Table

HR Half Round Wire

HR

• 50% PROFILE = FULL HALF ROUND • APROXIMATE WEIGHT PER CM
• WIRES ARE SUPPLIED HALF HARD UNLESS SPECIFIED

Width (mm)	9Y	9W	18Y	18W	SS
10.00 x 5.00	4.38	4.93	6.09	6.14	4.07
9.75 x 4.88	4.16	4.68	5.78	5.83	3.86
9.50 x 4.75	3.95	4.45	5.50	5.54	3.67
9.25 x 4.63	3.74	4.21	5.21	5.25	3.48
9.00 x 4.50	3.55	3.99	4.93	4.97	3.30
8.75 x 4.38	3.35	3.77	4.66	4.69	3.11
8.50 x 4.25	3.17	3.56	4.40	4.44	2.94
8.25 x 4.13	2.98	3.35	4.14	4.17	2.76
8.00 x 4.00	2.80	3.15	3.90	3.93	2.60
7.75 x 3.88	2.63	2.95	3.65	3.68	2.44
7.50 x 3.75	2.46	2.77	3.43	3.45	2.29
7.25 x 3.63	2.30	2.59	3.20	3.22	2.13
7.00 x 3.50	2.15	2.41	2.98	3.01	1.99
6.75 x 3.38	2.00	2.25	2.78	2.80	1.85
6.50 x 3.25	1.85	2.08	2.57	2.59	1.72
6.25 x 3.13	1.71	1.93	2.38	2.40	1.59
6.00 x 3.00	1.58	1.77	2.19	2.21	1.46
5.75 x 2.88	1.45	1.63	2.01	2.03	1.35
5.50 x 2.75	1.33	1.49	1.84	1.86	1.23
5.25 x 2.63	1.21	1.36	1.68	1.69	1.12
5.00 x 2.50	1.10	1.23	1.52	1.54	1.02
4.75 x 2.38	0.99	1.11	1.37	1.39	0.92
4.50 x 2.25	0.89	1.00	1.23	1.24	0.82
4.25 x 2.13	0.79	0.89	1.10	1.11	0.73
4.00 x 2.00	0.70	0.79	0.97	0.98	0.65
3.75 x 1.88	0.62	0.69	0.86	0.86	0.57
3.50 x 1.75	0.54	0.60	0.75	0.75	0.50
3.25 x 1.63	0.46	0.52	0.64	0.65	0.43
3.00 x 1.50	0.39	0.44	0.55	0.55	0.37
2.90 x 1.45	0.37	0.41	0.54	0.52	0.34
2.80 x 1.40	0.34	0.39	0.48	0.48	0.32
2.70 x 1.35	0.32	0.36	0.44	0.45	0.30
2.60 x 1.30	0.30	0.33	0.41	0.42	0.28
2.50 x 1.25	0.27	0.31	0.38	0.38	0.25
2.40 x 1.20	0.25	0.28	0.35	0.35	0.23
2.30 x 1.15	0.23	0.26	0.32	0.32	0.22
2.20 x 1.10	0.21	0.21	0.29	0.30	0.20
2.10 x 1.05	0.19	0.22	0.27	0.28	0.18
2.00 x 1.00	0.18	0.20	0.24	0.25	0.16
1.90 x 0.95	0.16	0.18	0.22	0.22	0.15
1.80 x 0.90	0.14	0.16	0.20	0.20	0.13
1.70 x 0.85	0.13	0.14	0.18	0.18	0.12
1.60 x 0.80	0.11	0.13	0.16	0.16	0.10
1.50 x 0.75	0.10	0.11	0.14	0.14	0.09
1.40 x 0.70	0.09	0.10	0.12	0.12	0.08
1.30 x 0.65	0.07	0.08	0.10	0.10	0.07
1.20 x 0.60	0.06	0.07	0.09	0.09	0.06
1.10 x 0.55	0.05	0.06	0.07	0.07	0.05
1.00 x 0.50	0.04	0.05	0.06	0.06	0.04

PETER W BECK

Size & Weight Table

HRL Half Round Wire Low Profile

• 33% PROFILE = LOW HALF ROUND • APPROXIMATE WEIGHT PER CM
• WIRES ARE SUPPLIED HALF HARD UNLESS SPECIFIED

Width (mm)	9Y	9W	18Y	18W	SS
15.00 x 4.95	5.98	6.72	8.31	8.38	5.55
14.75 x 4.87	5.78	6.50	8.04	8.11	5.37
14.50 x 4.78	5.58	6.27	7.76	7.82	5.18
14.25 x 4.70	5.39	6.06	7.50	7.56	5.01
14.00 x 4.62	5.21	5.86	7.24	7.30	4.84
13.75 x 4.54	5.03	5.65	6.99	7.04	4.67
13.50 x 4.46	4.85	5.45	6.74	6.79	4.50
13.25 x 4.37	4.66	5.24	6.48	6.53	4.33
13.00 x 4.30	4.50	5.06	6.26	6.31	4.18
12.75 x 4.20	4.31	4.85	5.99	6.04	4.00
12.50 x 4.15	4.18	4.70	5.81	5.86	3.88
12.25 x 4.05	4.00	4.49	5.55	5.60	3.71
12.00 x 3.95	3.82	4.29	5.30	5.35	3.54
11.75 x 3.90	3.69	4.15	5.13	5.18	3.43
11.50 x 3.80	3.52	3.96	4.89	4.93	3.27
11.25 x 3.70	3.35	3.77	4.66	4.70	3.11
11.00 x 3.65	3.24	3.64	4.50	4.53	3.00
10.75 x 3.55	3.07	3.46	4.27	4.31	2.85
10.50 x 3.45	2.92	3.28	4.08	4.09	2.71
10.25 x 3.40	2.81	3.16	3.90	3.94	2.61
10.00 x 3.30	2.66	2.99	3.69	3.72	2.47
9.75 x 3.20	2.51	2.82	3.49	3.52	2.33
9.50 x 3.15	2.41	2.71	3.35	3.38	2.24
9.25 x 3.05	2.27	2.55	3.16	3.18	2.11
9.00 x 2.95	2.14	2.40	2.97	2.99	1.98
8.75 x 2.89	2.04	2.29	2.83	2.85	1.89
8.50 x 2.80	1.92	2.15	2.66	2.69	1.78
8.25 x 2.75	1.83	2.06	2.54	2.56	1.70
8.00 x 2.65	1.71	1.92	2.37	2.39	1.59
7.75 x 2.55	1.59	1.79	2.21	2.23	1.48
7.50 x 2.50	1.51	1.70	2.10	2.12	1.40
7.25 x 2.40	1.40	1.58	1.95	1.96	1.30
7.00 x 2.30	1.30	1.46	1.80	1.82	1.20
6.75 x 2.25	1.22	1.38	1.70	1.72	1.14
6.50 x 2.15	1.13	1.27	1.56	1.58	1.05
6.25 x 2.05	1.03	1.16	1.43	1.44	0.96
6.00 x 2.00	0.97	1.09	1.34	1.36	0.90
5.75 x 1.90	0.88	0.99	1.22	1.23	0.82
5.50 x 1.80	0.80	0.90	1.11	1.12	0.74
5.25 x 1.75	0.74	0.83	1.03	1.04	0.69
5.00 x 1.65	0.66	0.75	0.92	0.93	0.62
4.75 x 1.55	0.59	0.67	0.82	0.83	0.55
4.50 x 1.50	0.54	0.61	0.76	0.76	0.51
4.25 x 1.40	0.48	0.54	0.67	0.67	0.44
4.00 x 1.30	0.42	0.47	0.58	0.59	0.39
3.75 x 1.25	0.38	0.43	0.53	0.53	0.35
3.50 x 1.15	0.32	0.36	0.45	0.45	0.30
3.25 x 1.10	0.29	0.32	0.40	0.40	0.27
3.00 x 1.00	0.24	0.27	0.34	0.34	0.22
2.90 x 0.96	0.22	0.25	0.31	0.31	0.21
2.80 x 0.92	0.21	0.23	0.29	0.29	0.19
2.70 x 0.89	0.19	0.22	0.27	0.27	0.18
2.60 x 0.86	0.18	0.20	0.25	0.25	0.17
2.50 x 0.83	0.17	0.19	0.23	0.23	0.16
2.40 x 0.79	0.15	0.17	0.21	0.21	0.14
2.30 x 0.76	0.14	0.16	0.20	0.20	0.13
2.20 x 0.73	0.13	0.15	0.18	0.18	0.12
2.10 x 0.69	0.12	0.13	0.16	0.16	0.11
2.00 x 0.66	0.11	0.12	0.15	0.15	0.10

Size & Weight Table

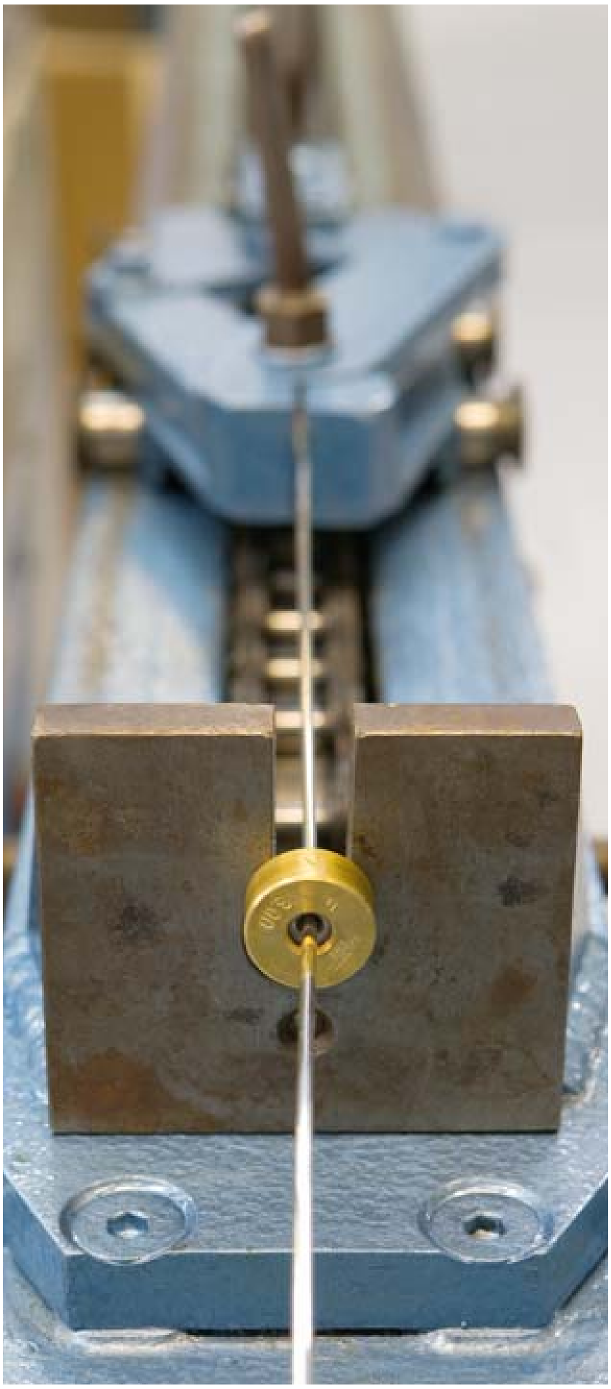
SW Square Wire

SW

• DRAWN FINISH • APPROXIMATE WEIGHT PER CM
• WIRES ARE SUPPLIED HALF HARD UNLESS SPECIFIED

Width (mm)	9Y	9W	18Y	18W	SS
7.00	5.47	6.15	7.60	7.66	5.08
6.75	5.08	5.72	7.07	7.12	4.72
6.50	4.71	5.30	6.55	6.61	4.38
6.25	4.36	4.90	6.06	6.11	4.05
6.00	4.02	4.52	5.58	5.63	3.73
5.75	3.69	4.15	5.13	5.17	3.43
5.50	3.38	3.80	4.69	4.73	3.13
5.25	3.08	3.46	4.28	4.31	2.86
5.00	2.79	3.14	3.88	3.91	2.59
4.75	2.52	2.83	3.50	3.53	2.34
4.50	2.26	2.54	3.14	3.17	2.10
4.25	2.02	2.27	2.80	2.82	1.87
4.00	1.79	2.01	2.48	2.50	1.66
3.75	1.57	1.76	2.18	2.20	1.46
3.50	1.37	1.54	1.90	1.92	1.27
3.25	1.18	1.33	1.64	1.65	1.09
3.00	1.00	1.13	1.40	1.41	0.93
2.75	0.84	0.95	1.17	1.18	0.78
2.50	0.70	0.78	0.97	0.98	0.65
2.40	0.64	0.72	0.89	0.90	0.60
2.25	0.56	0.64	0.79	0.79	0.52
2.20	0.54	0.61	0.75	0.76	0.50
2.00	0.45	0.50	0.62	0.63	0.41
1.80	0.36	0.41	0.50	0.51	0.34
1.60	0.29	0.32	0.40	0.40	0.27
1.50	0.25	0.28	0.35	0.35	0.23
1.40	0.22	0.25	0.30	0.31	0.20
1.30	0.19	0.21	0.26	0.26	0.18
1.25	0.17	0.20	0.24	0.24	0.16
1.20	0.16	0.18	0.22	0.23	0.15
1.10	0.14	0.15	0.19	0.19	0.13
1.00	0.11	0.13	0.16	0.16	0.10

Size & Weight Table



OW Oval Wire

OW

• 55% PROFILE = FULL OVAL • APPROXIMATE WEIGHT PER CM
• WIRES ARE SUPPLIED HALF HARD UNLESS SPECIFIED

Width (mm)	9Y	9W	18Y	18W	SS
8.00 x 4.40	3.09	3.47	4.29	4.32	2.86
7.75 x 4.26	2.90	3.23	4.02	4.06	2.69
7.50 x 4.13	2.71	3.05	3.77	3.80	2.52
7.25 x 3.99	2.53	2.85	3.52	3.55	2.35
7.00 x 3.85	2.36	2.66	3.28	3.31	2.19
6.75 x 3.71	2.20	2.47	3.05	3.08	2.04
6.50 x 3.58	2.04	2.29	2.83	2.85	1.89
6.25 x 3.44	1.88	2.12	2.62	2.64	1.75
6.00 x 3.30	1.74	1.95	2.41	2.43	1.61
5.75 x 3.16	1.59	1.79	2.22	2.23	1.48
5.50 x 3.03	1.46	1.64	2.03	2.04	1.35
5.25 x 2.89	1.33	1.49	1.85	1.86	1.23
5.00 x 2.75	1.21	1.36	1.67	1.69	1.12
4.75 x 2.61	1.09	1.22	1.51	1.52	1.01
4.50 x 2.48	0.98	1.10	1.36	1.37	0.91
4.25 x 2.34	0.87	0.98	1.21	1.22	0.81
4.00 x 2.20	0.77	0.87	1.07	1.08	0.72
3.75 x 2.06	0.68	0.76	0.94	0.95	0.63
3.50 x 1.93	0.59	0.66	0.82	0.83	0.55
3.25 x 1.79	0.51	0.57	0.71	0.71	0.47
3.00 x 1.65	0.43	0.49	0.60	0.61	0.40
2.90 x 1.60	0.41	0.46	0.56	0.57	0.38
2.80 x 1.54	0.38	0.43	0.53	0.53	0.35
2.70 x 1.49	0.35	0.40	0.49	0.49	0.33
2.60 x 1.43	0.33	0.37	0.45	0.46	0.30
2.50 x 1.38	0.30	0.34	0.42	0.42	0.28
2.40 x 1.32	0.28	0.31	0.39	0.39	0.26
2.30 x 1.27	0.26	0.29	0.35	0.36	0.24
2.20 x 1.21	0.23	0.26	0.32	0.33	0.22
2.10 x 1.16	0.21	0.24	0.30	0.30	0.20
2.00 x 1.10	0.19	0.22	0.27	0.27	0.18
1.90 x 1.05	0.17	0.20	0.24	0.24	0.16
1.80 x 0.99	0.16	0.18	0.22	0.22	0.14
1.70 x 0.93	0.14	0.16	0.19	0.20	0.13
1.60 x 0.88	0.12	0.14	0.17	0.17	0.11
1.50 x 0.82	0.11	0.12	0.15	0.15	0.10
1.40 x 0.77	0.09	0.11	0.13	0.13	0.09
1.30 x 0.71	0.08	0.09	0.11	0.11	0.08
1.20 x 0.66	0.07	0.08	0.10	0.10	0.06
1.10 x 0.60	0.06	0.07	0.08	0.08	0.05
1.00 x 0.55	0.05	0.05	0.07	0.07	0.04

PETER W BECK

Size & Weight Table

OWL Oval Wire Low Profile

• 33% PROFILE = LOW OVAL • APPROXIMATE WEIGHT PER CM
• WIRES ARE SUPPLIED HALF HARD UNLESS SPECIFIED

Width (mm)	9Y	9W	18Y	18W	SS
10.00 x 3.30	2.89	3.25	4.02	4.05	2.69
9.75 x 3.22	2.75	3.09	3.82	3.86	2.55
9.50 x 3.14	2.61	2.94	3.63	3.66	2.43
9.25 x 3.05	2.47	2.78	3.44	3.47	2.30
9.00 x 2.97	2.34	2.63	3.26	3.28	2.17
8.75 x 2.89	2.22	2.49	3.08	3.11	2.06
8.50 x 2.81	2.09	2.35	2.91	2.93	1.94
8.25 x 2.72	1.97	2.21	2.73	2.76	1.83
8.00 x 2.64	1.85	2.08	2.57	2.59	1.72
7.75 x 2.56	1.74	1.96	2.42	2.44	1.61
7.50 x 2.48	1.63	1.83	2.27	2.28	1.51
7.25 x 2.39	1.52	1.71	2.11	2.13	1.41
7.00 x 2.31	1.42	1.59	1.97	1.99	1.32
6.75 x 2.23	1.32	1.48	1.83	1.85	1.22
6.50 x 2.15	1.22	1.38	1.70	1.72	1.14
6.25 x 2.06	1.13	1.27	1.57	1.58	1.05
6.00 x 1.98	1.04	1.17	1.45	1.46	0.97
5.75 x 1.90	0.96	1.08	1.33	1.34	0.89
5.50 x 1.82	0.88	0.99	1.22	1.23	0.81
5.25 x 1.73	0.80	0.90	1.11	1.12	0.74
5.00 x 1.65	0.72	0.81	1.00	1.01	0.67
4.75 x 1.57	0.65	0.74	0.91	0.92	0.61
4.50 x 1.49	0.59	0.66	0.82	0.82	0.55
4.25 x 1.40	0.52	0.59	0.72	0.73	0.48
4.00 x 1.32	0.46	0.52	0.64	0.65	0.43
3.75 x 1.24	0.41	0.46	0.57	0.57	0.38
3.50 x 1.16	0.36	0.58	0.49	0.50	0.33
3.25 x 1.07	0.30	0.54	0.42	0.43	0.28
3.00 x 0.99	0.26	0.29	0.36	0.36	0.24
2.90 x 0.96	0.24	0.27	0.34	0.34	0.23
2.80 x 0.92	0.23	0.25	0.31	0.32	0.21
2.70 x 0.89	0.21	0.24	0.29	0.30	0.20
2.60 x 0.86	0.20	0.22	0.27	0.27	0.18
2.50 x 0.83	0.18	0.20	0.25	0.25	0.17
2.40 x 0.79	0.17	0.19	0.23	0.23	0.15
2.30 x 0.76	0.15	0.17	0.21	0.21	0.14
2.20 x 0.73	0.14	0.16	0.20	0.20	0.13
2.10 x 0.69	0.13	0.14	0.18	0.18	0.12
2.00 x 0.66	0.12	0.13	0.16	0.16	0.11
1.90 x 0.63	0.10	0.12	0.15	0.15	0.10
1.80 x 0.59	0.09	0.10	0.13	0.13	0.09
1.70 x 0.56	0.08	0.09	0.12	0.12	0.08
1.60 x 0.53	0.07	0.08	0.10	0.10	0.07
1.50 x 0.50	0.07	0.07	0.09	0.09	0.06

Size & Weight Table

CH Chenier

CH

- APPROXIMATE WEIGHT PER CM
- CHENIER SUPPLIED HALF HARD UNLESS SPECIFIED

Outside Diam x Inside Diam x Wall Thickness (mm)	9Y	9W	18Y	18W	SS	PT950
8.00 x 6.00 x 1.00	-	-	-	-	2.28	-
7.50 x 5.50 x 1.00	-	-	-	-	2.12	-
7.00 x 5.00 x 1.00	2.10	2.37	2.92	2.95	1.95	-
6.50 x 4.50 x 1.00	1.93	2.17	2.68	2.70	1.79	-
6.00 x 4.40 x 0.80	1.46	1.64	2.03	2.04	1.35	2.65
5.50 x 3.90 x 0.80	1.32	1.48	1.83	1.85	1.22	-
5.00 x 3.40 x 0.80	1.18	1.32	1.64	1.65	1.09	2.15
4.50 x 3.30 x 0.60	0.82	0.92	1.14	1.15	0.76	-
4.00 x 2.80 x 0.60	0.72	0.80	0.99	1.00	0.66	1.31
3.75 x 2.55 x 0.60	0.66	0.75	0.92	0.93	0.62	-
3.50 x 2.50 x 0.50	0.53	0.59	0.73	0.74	0.49	-
3.25 x 2.25 x 0.50	0.48	0.54	0.67	0.68	0.45	-
3.00 x 2.00 x 0.50	0.44	0.49	0.61	0.61	0.41	0.80
2.75 x 1.75 x 0.50	0.39	0.44	0.55	0.55	0.37	-
2.50 x 1.50 x 0.50	0.35	0.39	0.49	0.49	0.33	-
2.25 x 1.25 x 0.50	0.31	0.34	0.43	0.43	0.28	-
2.00 x 1.00 x 0.50	0.26	0.30	0.37	0.37	0.24	0.47
1.75 x 1.15 x 0.30	0.15	0.17	0.21	0.21	0.14	-
1.50 x 0.90 x 0.30	0.13	0.14	0.18	0.18	0.12	-
1.25 x 0.65 x 0.30	-	-	-	-	0.09	-
1.00 x 0.50 x 0.25	-	-	-	-	0.06	-

Size & Weight Table

ST Strip

ST

- APPROXIMATE WEIGHT PER CM
- STRIP SUPPLIED HALF HARD UNLESS SPECIFIED

Width x Thickness (mm)	9Y	9W	18Y	18W	SS
6.40 x 2.20	1.57	1.77	2.18	2.20	1.46
6.40 x 1.20	0.86	0.96	1.19	1.20	0.80
6.20 x 2.10	1.45	1.63	2.02	2.04	1.35
6.20 x 1.10	0.76	0.86	1.06	1.07	0.71
6.00 x 2.00	1.34	1.51	1.86	1.88	1.24
6.00 x 1.00	0.67	0.75	0.93	0.94	0.62
5.40 x 2.20	1.33	1.49	1.84	1.86	1.23
5.40 x 1.20	0.72	0.81	1.01	1.01	0.67
5.40 x 0.70	0.42	0.47	0.59	0.59	0.39
5.20 x 2.10	1.22	1.37	1.69	1.71	1.13
5.20 x 1.10	0.64	0.72	0.89	0.89	0.59
5.20 x 0.60	0.35	0.39	0.48	0.49	0.32
5.00 x 2.00	1.12	1.26	1.55	1.56	1.04
5.00 x 1.00	0.56	0.63	0.78	0.78	0.52
5.00 x 0.50	0.28	0.31	0.39	0.39	0.26
4.40 x 2.20	1.08	1.21	1.50	1.51	1.00
4.40 x 1.20	0.59	0.66	0.82	0.83	0.55
4.40 x 0.70	0.34	0.39	0.48	0.48	0.32
4.20 x 2.10	0.98	1.11	1.37	1.38	0.91
4.20 x 1.10	0.52	0.58	0.72	0.72	0.48
4.20 x 0.60	0.28	0.32	0.39	0.39	0.26
4.00 x 2.00	0.89	1.00	1.24	1.25	0.83
4.00 x 1.00	0.45	0.50	0.62	0.63	0.41
4.00 x 0.50	0.22	0.25	0.31	0.31	0.21
3.40 x 1.70	0.65	0.73	0.90	0.90	0.60
3.40 x 1.20	0.46	0.51	0.63	0.64	0.42
3.40 x 0.70	0.27	0.30	0.37	0.37	0.25
3.20 x 1.60	0.57	0.64	0.79	0.80	0.53
3.20 x 1.10	0.39	0.44	0.55	0.55	0.36
3.20 x 0.60	0.21	0.24	0.30	0.30	0.20
3.00 x 1.50	0.50	0.56	0.70	0.70	0.47
3.00 x 1.00	0.33	0.38	0.47	0.47	0.31
3.00 x 0.50	0.17	0.19	0.23	0.23	0.16
2.40 x 1.20	0.32	0.36	0.45	0.45	0.30
2.40 x 0.70	0.19	0.21	0.26	0.26	0.17
2.20 x 1.10	0.27	0.30	0.38	0.38	0.25
2.20 x 0.60	0.15	0.17	0.20	0.21	0.14
2.00 x 1.00	0.22	0.25	0.31	0.31	0.21
2.00 x 0.50	0.11	0.13	0.16	0.16	0.10

Size & Weight Table

SH Sheet

SH

• APPROXIMATE WEIGHT PER CM² • ALL SHEET SUPPLIED FULLY ANNEALED • MAY HAVE ROLLED OR POLISHED FINISH • ALL SHEET SUPPLIED WITH GUILLOTINE CUT EDGES • STANDARD SILVER SHEET STOCK SIZE 100MM X 300MM

Thickness (mm)	9Y	9W	18Y	18W	SS
2.00	2.232	2.510	3.102	3.128	2.072
1.80	2.009	2.259	2.792	2.815	1.865
1.70	1.897	2.134	2.637	2.665	1.761
1.60	1.786	2.008	2.482	2.502	1.658
1.50	1.674	1.883	2.327	2.346	1.554
1.20	1.339	1.506	1.861	1.877	1.243
1.00	1.116	1.255	1.551	1.564	1.036
0.90	1.004	1.130	1.396	1.408	0.932
0.80	0.893	1.004	1.241	1.251	0.829
0.70	0.781	0.879	1.086	1.095	0.725
0.60	0.670	0.753	0.931	0.938	0.622
0.50	0.558	0.628	0.776	0.782	0.518
0.40	0.446	0.502	0.620	0.626	0.414
0.30	0.335	0.377	0.465	0.469	0.311

OVER 2.00MM - CALL CUSTOMER SERVICE FOR AVAILABILITY

Services & Ordering

Peter W Beck Precious Metal Services®

Toll Free 1800 888 590
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Email preciousmetals@pwbeck.com.au
Web www.pwbeck.com.au

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At Peter W Beck Pty Ltd we are continuously developing and improving our product range, as a consequence we reserve the right to alter product specifications without notice.

Services

Rework

Clean fabrication metal scrap can be remelted and reworked into a variety of fabricated profiles.

- Minimum quantity of 100gms required
- Metal must be clean fabrication metal
- A minimum weight loss of 3% will apply
- Standard turnaround is ten working days. Large quantities will require longer production times

Contamination by casting metals, solders, some base metals and oxidisation will invariably result in metal failure during rework. Service charges are still incurred by the customer if this occurs.

Peter W Beck Pty Ltd takes no responsibility for the alloy carat or final workability after remelting and reworking.

Granulation

Clean metal in scrap or ingot form can be granulated by our Production team.

- Minimum quantity of 100gms required
- A minimum weight loss of 3% will apply
- Standard turnaround is five working days. Large quantities will require longer production times

Most jewellery alloys can be granulated by our Production team, however, Peter W Beck Pty Ltd reserves the right to refuse to handle some alloys deemed to be hazardous or outside the scope of this intended service.

Ingotting Service

Clean fabricating scrap can be remelted into ingots for further cold working by the customer.

- Minimum quantity of 100gms required
- Minimum weight loss of 3% will apply
- Standard turnaround is seven working days

This is a specialised service, please contact our Customer Service staff who can calculate the minimum weight required for various size ingots.

Annealing Service

Metals can be fully annealed in our atmospherically controlled annealing furnace.

- Maximum size of the article must not exceed 400mm L x 230mm W x 50mm H
- Standard turnaround time is five working days

Express Service

If you require metal earlier than our standard production times allow, you will be happy to know that we can offer an Express Service for wire and sheet. The extra charge incurred by this service enables our Production team to dedicate the necessary resources to prioritise your order. The turnaround time obviously depends on the size of the order to be completed.

Bangle Coil

We offer several different profiles of high finish drawn wire and if requested, we can coil the wire and saw the ends square to the exact length needed for a nominal charge. Please refer to page 157 for information on calculating length.

Ordering

Your orders are input into our system in one of two ways:

1. You may order by **Weight** eg. 40 grams of 18 carat yellow 4.50mm square wire or
2. You may order by **Dimension** eg. 40mm of 18 carat yellow 4.50mm square wire

In both situations we require essential product information to ensure we process your order accurately and deliver it to you on time. From the Alloy Tables you will find the available fabricated profiles, alloy code and full description.

Quotation in Advance

We can supply you with an instant no obligation quotation in advance of placing your orders. All you are required to do is have the relevant information ready when you call our Customer Service team. They will be able to calculate accurate weights, the price for that day and give you expected delivery times for your specific order.

When Ordering by Weight

The information required is as follows:

Weight Unit	Alloy Code & Description	Profile	Dimensions
Grams	Obtained from the alloy tables	The available profiles for the alloy of interest are given in the available forms column	At least two dimensions are required Length and/or width and/or thickness (Units - mm)

For Example:

Weight Unit	Alloy Code & Description	Profile	Dimensions
100gms	18Y	SGW	4.5mm square

or

Weight Unit	Alloy Code & Description	Profile	Dimensions
100gms	18ct Yellow	Standard Gauge Wire	4.5mm square

When Ordering by Dimension

The information required is as follows:

Units	Alloy Code & Description	Profile	Dimensions
Number of pieces required	Obtained from the alloy tables	The available profiles for the alloy of interest are given in the available forms column	At least three dimensions are required Length x Width x Thickness (Units mm)

For Example:

Units	Alloy Code & Description	Profile	Dimensions
1 piece	SS	SH	150mm x 100mm x 1mm

or

Units	Alloy Code & Description	Profile	Dimensions
1 piece	Sterling Silver	Sheet	150mm x 100mm x 1mm

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Plating Solutions, Cleaning Salts & Solder Fluxes

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Plating Solutions & Cleaning Salts

Plating Solutions*

Code	Description	Colour	Availability	Form	Mixing	Bath Temp °C	Voltage	Period
GPS	Gold Plating Solution *Contains 0.4gm Gold*	Yellow	1 Litre Bottle	Liquid	Ready To Use	60	5	30 - 60 Seconds
RPS	Rhodium Plating Concentrate *Contains 2gm Rhodium*	White	100ml Bottle	Liquid	100ml/1 Litre Demin Water	40 - 45	4 - 4.5	15 - 60 Seconds

Cleaning Salts*

Code	Description/Application	Availability	Form	Mixing	Bath Temp °C	Voltage	Period
ECS	Electrolytic Cleaning Salts *Pre-plating electro cleaner*	750gm Jar	Powder	50 - 60gm/1 Litre Demin Water	50	5 - 6	60 Seconds
ACD	Acid Dip *Pre-plating neutraliser & surface activator*	750gm Jar	Powder	50 - 60gm/1 Litre Demin Water	Room Temperature	Nil	30 Seconds

*Full instruction sheet available on request

Solder Fluxes

Solder Fluxes

Code	Description/Application	Colour	Availability	Form
GPFL	GP Flux *General purpose multi-alloy solder flux*	White	250gm Jar	Paste
AUFL	Gold Flux *General purpose Gold solder flux*	Yellow	100ml Bottle	Liquid

Casting & Moulding

Peter W Beck Pty Ltd has a long established department dedicated to and specialising in the casting of jewellery products in Gold, Silver, Platinum and Palladium alloys. We provide a full range of casting services, including specialised casting alloys, moulding, wax resizing and design confidentiality.

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Casting & Moulding Index

Gold, Silver, Platinum & Palladium Casting Alloys

Moulds

Casting Services Information

Services & Ordering

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At Peter W Beck Pty Ltd we are continuously developing and improving our product range, as a consequence we reserve the right to alter product specifications without notice.

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Alloy Properties Definitions

CASTING ALLOYS

Alloy Code

Each alloy has its individual product code. When ordering a specific alloy, please use this code on your order or quote it to our Customer Service consultants.

Description

The information in this column will identify the alloy.

Minimum Gold Content

The carat of an alloy is most commonly expressed as fineness that is, parts per thousand (750 = 18 carat, based on 24 carat being 1000).

Principle Elements

The main constituent elements of the alloy appear in this column. The following chemical symbols are used to identify these elements:

Au Gold	**Ag** Silver	**Pt** Platinum
Pd Palladium	**Cu** Copper	**Zn** Zinc
Ni Nickel	**Ru** Ruthenium	

Where Nickel is expressed in brackets as (Ni) in the 'Principle Elements' column, the Nickel content of the alloy is lesser than 1%.

Colour

We have described the colour of each alloy (as polished) to assist you with your selection, these descriptions however are intended to act only as a guide. In the case of white Golds we have applied the "White Gold Scale" which is described in more detail on page 149.

Liquidus Solidus

Liquidus refers to the temperature above which an alloy or metal is entirely molten. *Solidus* refers to the temperature below which an alloy or metal is completely solid.

See Glossary for further definitions.

Density G/cm^3

Mass per unit volume expressed as grams per cubic centimeter of the alloy. This can be used to compare the weight of the same product in different alloys or even to identify one alloy from another.

Master Alloys

If you prefer alloying your own metals we have a master alloy range to simplify the process. Combining specific amounts of Fine Gold with the chosen master alloy produces a purpose designed alloy for the specific carat required.

Gold Casting Alloys

WE OFFER A CUSTOM CASTING SERVICE THAT COMBINES QUALITY AND CONSISTENCY WITH QUICK TURN AROUND. OUR METAL QUALITY IS ASSURED BECAUSE WE MANUFACTURE AND QUALITY CONTROL ALL OF OUR METALS VIA OUR IN HOUSE ASSAY LABORATORY.

22 Carat Gold Casting Alloy

Code	Description	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus °C	Density G/cm³	Master Alloy Available
22YC	22ct Yellow Casting	917	Au, Ag, Cu, Zn	Royal Yellow	996 - 990	17.86	Yes

18 Carat Gold Casting Alloys

Code	Description	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus °C	Density G/cm³	Master Alloy Available
18YC	18ct Yellow Casting	750	Au, Ag, Cu, Zn	Rich Yellow	905 - 880	15.51	Yes
18PC	18ct Pink Casting	750	Au, Ag, Pd, Cu	Yellow Pink	900 - 870	15.17	Yes
18WGC	18ct White General Casting	750	Au, Ag, Pd, Cu, Zn	Grey White YI 17	1090 - 960	16.05	Yes
18WC	18ct White Casting	750	Au, Ag, Pd, Cu, Zn	Grey White YI 31	1062 - 1031	15.65	Yes

14 Carat Gold Casting Alloys

Code	Description	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus °C	Density G/cm³	Master Alloy Available
14YC	14ct Yellow Casting	585	Au, Ag, Cu, Zn	Yellow	862 - 853	12.96	Yes
14PC	14ct Pink Casting	585	Au, Ag, Cu, Zn	Pink	889 - 875	13.09	Yes
14WC	14ct White Casting	585	Au, Ag, Pd, Cu, Zn, (Ni)	Grey White YI 19	1011 - 999	14.19	Yes

WHERE NICKEL IS EXPRESSED BRACKETED (Ni) IN THE "PRINCIPLE ELEMENTS" COLUMN, THE NICKEL CONTENT OF THE ALLOY IS LESSER THAN 1% WHEN ALLOYED WITH FINE GOLD

10 Carat Gold Casting Alloy

Code	Description	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus °C	Density G/cm³	Master Alloy Available
10YC	10ct Yellow Casting	417	Au, Ag, Cu, Zn	Warm Yellow	834 - 831	11.48	Yes

9 Carat Gold Casting Alloys

Code	Description	Min. Gold Content	Principle Elements	Colour	Liquidus Solidus °C	Density G/cm³	Master Alloy Available
9YC	9ct Yellow Casting	375	Au, Ag, Cu, Zn	Warm Yellow	899 - 851	11.16	Yes
9PC	9ct Pink Casting	375	Au, Ag, Cu, Zn	Pink Red	958 - 944	11.23	Yes
9WC	9ct White Casting	375	Au, Ag, Pd, Zn	White YI 14	971 - 948	12.55	Yes

Silver, Platinum & Palladium Casting Alloys

Silver Casting Alloy

Code	Description	Min. Silver Content	Principle Elements	Colour	Liquidus Solidus °C	Density G/cm³	Master Alloy Available
925AG1C	925 Oxide Resistant Silver Casting	925	Ag, Cu, Zn	White	899 - 778	10.30	Yes

Platinum Casting Alloys

Code	Description	Min. Platinum Content	Principle Elements	Colour	Liquidus Solidus °C	Density G/cm³	Master Alloy Available
PT9501C	95% Platinum/ Palladium Casting	950	Pt, Pd	White	1650 Melting Point	19.76	No
PT950RUC	95% Platinum/ Ruthenium Casting	950	Pt, Ru	White	1790 - 1780	20.70	No

Palladium Casting Alloy

Code	Description	Min. Palladium Content	Principle Elements	Colour	Liquidus Solidus °C	Density G/cm³	Master Alloy Available
PD950AGC	95% Palladium/Silver Casting	950	Pd, Ag	White	1450 - 1380	11.80	No

Moulds

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Mould Materials

The primary aim of our mould makers is to make a mould that faithfully reproduces the master with maximum integrity and with minimum imperfections. This will ensure a finished cast piece that requires minimum finishing time.

We have several options available to us when we produce a mould from your master pattern. Our moulding compounds come in pourable forms, putty or in rubber sheets. We have an option for virtually every scenario and as new compounds and techniques become available we will strive to keep at the forefront of moulding technology. The mould frames that we use are available in many sizes and thicknesses which offer us plenty of scope when matching the correct size mould to the size of your piece. We have the experience, technical ability and equipment to produce the best possible cast copy of your design.

Although there are many different moulding materials available, they generally fall into two main categories:

Room Temperature Vulcanised (RTV) moulds

High Temperature Vulcanised (HTV) moulds

Most RTV moulds are cured by a chemical reaction when two components are mixed together at room temperature and the HTV moulds are cured by heating the rubber compound under pressure. It should be noted that High Temperature Vulcanised rubber is the most common material used to mould jewellery.

Room Temperature Moulds

RTV moulds offer the following advantages:

- Minimises the possibility of damaging the master pattern
- Room temperature curing enables masters to be made from heat sensitive material
- Low shrinkage from master pattern to reproduction pieces

Some of the disadvantages of RTV moulds are:

- Low mould durability. RTV moulds are more likely to tear and hence reduce the life of the mould
- More prominent mould lines. The low amount of flex in the RTV material reduces the amount the mould can compress and form a complete seal where the two mould halves meet
- Greater restrictions on design detailing in particular intricate setting designs that exhibit many cavities and openings from which the moulding material must be released
- Size limitations due to the curing and cutting dynamics of the material
- Delicate designs must be able to withstand vacuum pressures
- The reactive nature of ingredients used to make RTV moulds requires the master patterns to be clean and free of any surface contaminants

The lack of flexibility of RTV material lends itself naturally to simple geometric designs, for example flat objects that do not require the moulding material to undergo any great deformation to release the design or wax model.

High Temperature Moulds

HTV moulds offer the following advantages:

- Economy
- Durability
- Design Flexibility

As mentioned previously HTV moulds are the most popular moulds used in the casting of jewellery. The benefit for the jeweller is that most designs can be accommodated in this material due to its flexibility and durability. The results are very good and are well suited to jewellery reproductions where there is further working and finishing procedures in the manufacturing process.

Some of the disadvantages of HTV moulds are:

- The vulcanising process (heating and pressure) results in shrinkage from master pattern to copy due to the contraction of the rubber as it cools
- Not suited to some delicate and hollow products due to the pressure applied during vulcanising

Mould Storage

Mould Library

Customers are invited to store their moulds with us in our mould library; there are no storage costs for this service. Having the customer's mould/s in storage speeds up delivery times on casting orders, this is because we don't have to wait for the moulds to be sent to us before proceeding with the order. We offer security and confidentiality for your designs and of course all moulds are held in trust and will be returned to the customer at any time upon receipt of a written request. This also holds true for any mould/s made for the customer by our mould cutting service. Mould storage is optional so if requested we will return the mould/s to the customer with the cast products.

Tracking System

Every mould stored in our library is considered to be unique and is allocated an individual identification code. Firstly, this ensures we are able to track each individual order through the system, and importantly it also serves as a system security measure. Each individual mould identification code can only be ordered under the customer code that is the registered owner. This system therefore ensures design confidentiality and protects the inadvertent distribution of a design to anybody other than the recognised owner. Thus the identification code for a design may be CUSTO/1 ('customer code'/design #1) the first five letters also being the customer code.

Your own design numbers are also capable of being recorded and cross referenced in our system. We can provide you with a cross referenced register of your design numbers to assist with ordering and also to confirm the mould/s we are storing on your behalf.

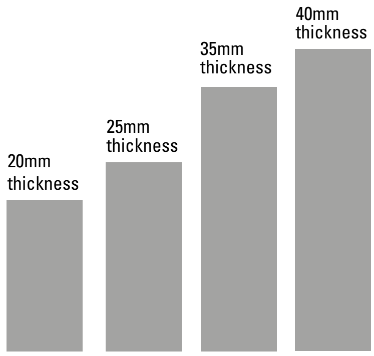
Mould Frame Sizes

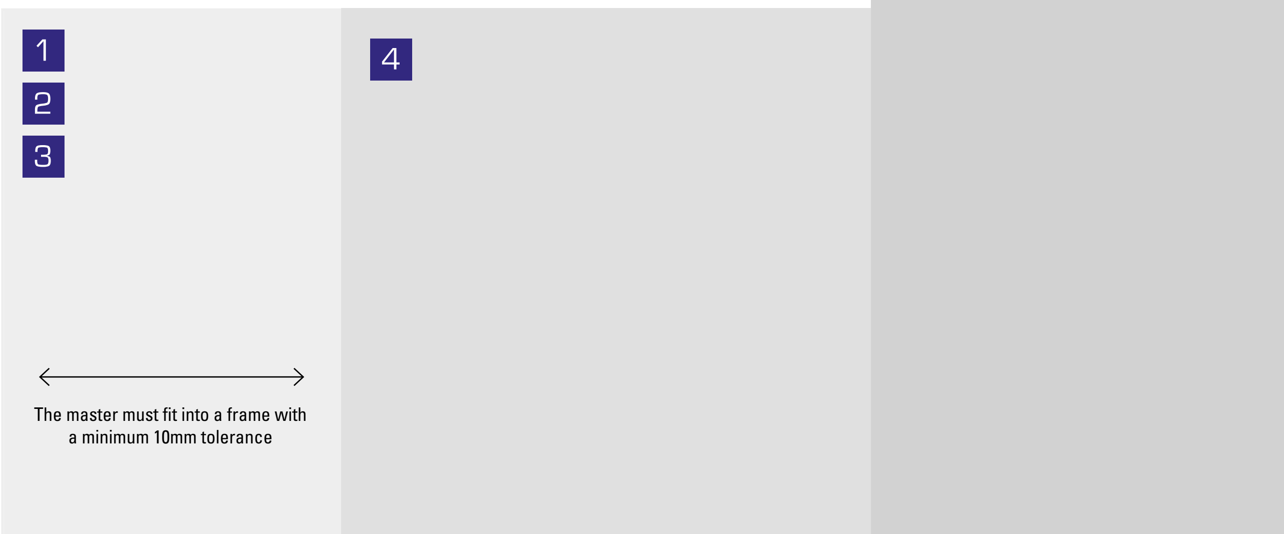
The mould frame sizes detailed below represent only the most common sizes used. Please contact our Customer Service team for assistance if other frame sizes are required.

Standard mould dimensions (millimetres)
(width x length x thickness)

1 45 x 70 x 20
2 45 x 70 x 25
3 45 x 70 x 35
4 70 x 70 x 20
5 55 x 130 x 25
6 75 x 95 x 40
7 95 x 115 x 40
8 100 x 150 x 40

Other mould sizes available.





Mould Sizes

There are limitations to the size of master pattern that can be moulded and cast. The above represents a guideline for customers wishing to use our service and is in no way exhaustive.

Mould Thickness

Maximum thickness of master should be limited to approximately two thirds of the total mould thickness. By example, mould 40mm thick - master 30mm maximum depth.

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1,2,3	Small Frame Mould
4,5	Medium Frame Mould
6,7,8	Large Frame Mould

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Casting Services Information

Peter W Beck Precious Metal Services®

Toll Free	1800 888 590
Telephone	08 8440 3399
Facsimile	08 8447 1144
Email	preciousmetals@pwbeck.com.au
Web	www.pwbeck.com.au

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Calculating metal weight from a wax using density

The specific gravity of wax is approximately 1.

To calculate the approximate weight of your wax in the required metal, simply multiply the wax weight by the Density (gm/cm^3) of the alloy you require.

For example: if a 0.42gm wax is to be cast in 9 carat yellow Gold the weight of the finished product would be:

0.42gm x 11.20 (density of 9 carat yellow) = 4.70gms.

As a quick reference use the following conversion figures.

Wax weight x conversion factor = approximate cast weight.

Alloy	Conversion Factor (Density)
22Y	17.90
18Y	15.50
18P	15.20
18W	15.70
14Y	13.00
14P	13.10
14W	14.20
10Y	11.50
9Y	11.20
9P	11.30
9W	12.60
SS	10.30
PLAT	20.70
PALL	11.80

Design factors affecting the quality of the cast product

There are two main reasons why castings are rejected:

1. Excessive porosity
2. Incomplete formation

The following information will help you to achieve the best possible results:

Moulding Material

The Master Pattern needs to be designed with the moulding process in mind. For High Temperature Vulcanised rubber moulding shrinkage must be allowed for, in particular in the case of a setting design where the stone size tolerance is small. If Room Temperature Vulcanised materials are to be used, for its low shrink characteristics, then the relative inflexibility of the material must be considered.

Removal of the Master and Wax Models

Allowances must be made for in the design to ensure there are no undercuts or bottlenecks that will eventually make it impossible to extract a wax model from the mould. By way of an example, a hollow filigree ball could not successfully be moulded; there is no possible way for the rubber, which would flow through the ball, to be extracted from inside the master. It may however be able to be removed if the ball is cut into two halves prior to moulding.

The results that are expected from poorly designed master patterns are often exhibited in either:

- Tearing of the mould on extraction of the master pattern
- Bending or breaking of the wax pattern on extraction from the mould. These problems are often insurmountable to the mould cutter

Master Pattern Materials

Where non-standard alloys (low melting point alloys, lesser than 180°C) are used for the construction material of a Master Pattern, it is advisable to note this on your order. This ensures the correct materials and techniques are employed by our mould cutters to accommodate the material and eliminate any chance of damage to your master.

Thickness of the Master Pattern

Thickness has a critical bearing on both producing wax patterns from a mould and ensuring that the final cast completely fills when molten metal is delivered into the mould cavity. The prime limitation here has to do with the speed at which the molten material, either wax or metal solidifies. Pieces that are too thin invariably do not fill due to the rapid chilling of the molten material. In simple terms thicker sections stay molten longer and consequently travel further in the mould cavity resulting in a complete fill.

Flow of Molten Materials

Related to the previous point, the designer must consider the feed source of the molten material to other sections within the piece. Unsuccessful fills and shrinkage porosity may be the result of thin sections feeding thicker sections in a design. These thin sections may chill before the thicker section is completely filled causing an unsuccessful cast or wax injection. The only way to overcome this is to provide a sprue to the heavier section that effectively bypasses the thinner feed source.

Mass can also have a bearing on the final product. A malformed wax, in the form of dishing, is sometimes unavoidable in large flat heavier sections of a design. This is caused by the shrinkage of the wax on cooling where delivery of the molten material is restricted and as such is unable to replace the volume required to maintain a complete fill of the mould. This may be avoided by hollowing out the back of the design to reduce the overall mass of the product or direct spruing to the problem area.

With the advent of CAD software and rapid prototyping machinery for the production of jewellery items it is important to design pieces with the casting process in mind. Using this


technology allows you to create very detailed and intricate master patterns which could not previously have been done by hand. To facilitate a casting of high integrity some thought should be given to things like the size and depth of lettering and how molten metal might flow through fine filigree sections. With a little thought the most intricate design may be achieved.

Unsuitable Materials

Some finishes or applications on masters are incompatible with the moulding materials used.

In particular:

- Copper-based alloys are inappropriate for HTV materials
- Sulphide based applications (eg Liver of Sulphur) react with RTV moulding materials

Sprue Placement

Placement of sprues is best left up to the technical experts in the moulding department. You do have final say on the positioning, however if there are any foreseeable problems affecting the eventual success of the cast, our Moulding Service personnel will advise of other options before proceeding.

The principles of sprue placement are as follows:

- Sprue thickness should be equal to or greater than the thickest section of the jewellery piece
- Sprue position should be located on the thickest section of the piece
- Multiple sprues should be used to feed heavy sections and where design constrictions inhibit the free flow of metal/wax to all extremities of the piece from the one sprue junction
- Sprues should be positioned in such a way that the metal/wax flow into the mould cavity is kept as free flowing as possible. Do not position sprues at right angles to the main axis of a design, if possible. This principle basically aims to avoid major turbulence and ensure the metal/wax flows unobstructed through the piece

Product Shrinkage

Three factors must be considered where shrinkage is a design issue:

1. Moulding material
2. The casting process
3. Mass of the model

As previously mentioned the designer/maker of the master pattern must be aware of the shrinkage that is the result of the casting process. The moulding material will vary the amount of shrinkage that will be exhibited in the final product. However the standard HTV rubber exhibits the greatest amount and the RTV materials the lowest. Usually the HTV material we use will exhibit approximately 3% to 4% shrinkage from master to wax model. The investing and casting processes may account for a further 3% or so (total shrinkage may be in the order of 6% to 10%). Using RTV materials usually results in less than 4% total shrinkage from master to casting.

Services & Ordering

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Services

Express Service

We recognise that from time to time you will need your castings returned before the standard turn around. We have introduced an Express Service to overcome this eventuality. This service applies to both the casting and moulding service and incurs an additional charge. For more details contact our Customer Service team.

Wax Resizing

For the cost of a single casting we can resize your injected waxes before they are cast saving time and metal wastage. We can also fill carat stamps, hollowed out sections or hide blemishes etc. prior to casting.

Customers Own Metal

You can supply us with your own alloy if you prefer. We will cast the tree for you and return it to you cleaned and intact. When casting in your alloy we are unable to offer the same quality guarantee that naturally comes with our own metals, however we will endeavor to provide you with the same quality service, employing all our skills and technology available so you receive the best possible results. As a general rule, you will need to supply approximately three and a half times the finished weight of the piece. Some weight loss will also be experienced; the amount will depend on the quality of the metal supplied. We do not accept responsibility for the final metal quality or carat rating.

Customer Feedback

We are able to produce castings from a master pattern for which a mould needs to be made, from a mould, a wax from a mould, a hand carved wax or a CAD produced master.

The quality of the final product is intrinsically linked to the quality of what is supplied. There are a number of stages to producing a casting and each stage of the process has its own set of risks that can result in a faulty casting. As such a number of issues must be addressed in order to ensure we produce a consistently high quality product.

The technical experts in our casting and moulding areas will advise our customers through our Customer Service consultants where there is a design feature of the piece that may prevent the successful casting or moulding of the piece. This communication with our customers is intended to provide an efficient quality control mechanism to avoid casting failure, costly delays in production or excessive finishing time of the cast piece.

Ordering

Supplying an Item for Casting

When supplying a wax, please include:

1. Your account code or your contact details
2. Nominate which alloy you would like it cast in

When supplying a mould, please include:

1. Your account code or your contact details
2. The number of castings you would like
3. Nominate which alloy you would like it cast in

When supplying a master, please include:

1. Your account code or your contact details
2. The number of moulds you require and if you would like us to store them
3. The moulding material if you have a preference (we would prefer to choose the appropriate moulding compound dependant on the style of the finished cast or the composition of the master)
4. The number of castings you would like
5. Nominate which alloy you would like it cast in

When using a mould stored in our library:

If you have a mould stored in our mould library, please phone our friendly Customer Service staff so we can assist you with the ordering process. You may prefer to email or fax your order through, including your mould number.

Guarantees

Quality Guarantee

Peter W Beck Pty Ltd will replace a faulty casting where we have supplied a product which does not meet an acceptable level of finish or where the moulding materials used were not appropriate.

Where poor results are determined to be design related we reserve the right not to give a full credit. This is contingent upon you being advised by us prior to casting that there are potential design flaws.

To ensure your castings are of the highest quality they are cleaned by a blasting process which removes all oxides and surface contamination. This process precedes visual inspection and assists in the detection of any faults. As a result we strive to deliver to you a high quality product with a clean skin ready for the final finish. The sprues are trimmed as close as practical to the piece avoiding distortion damage and ensuring you receive only the metal you require.

Confidentiality

It is the policy of the company to respect and stringently adhere to the confidentiality that has been entrusted in us by the owner or the designer of the design, the master, the wax or the mould.

Refining & Assaying

Peter W Beck Pty Ltd has over 30 years experience in Precious Metals, ensuring we have the knowledge and expertise required to refine Gold, Silver, Platinum and Palladium to the highest standard. Our reputation as a leading Australian owned refiner is based on our understanding of the accuracy and integrity that is essential when recovering precious metals. Our Refining Department maintains strict controls and recognises the degree of attention needed of all refining jobs, regardless of size or whether sourced from high or low grade material.

Refining & Assaying Index

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At Peter W Beck Pty Ltd we are continuously developing and improving our product range, as a consequence we reserve the right to alter product specifications without notice.

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Refining

Gold, Silver, Platinum & Palladium refining is considered one of the most difficult areas associated with the manufacturing and processing of precious metals.

The high intrinsic value and the technical, mechanical and chemical skills associated with refining places demands on the refiner to perform with the utmost accuracy and integrity with all refining jobs, both big and small, whether of high or low grade material.

Peter W Beck Pty Ltd recognises the need for accuracy and integrity in precious metal refining and has pursued these aims by employing the best equipment and experienced staff who are familiar with the unique requirements associated with every refining job.

To assist in the control process, Peter W Beck Pty Ltd has developed a sophisticated computer programme designed to monitor and track all refining jobs from receipts to payouts.

We see ourselves as a premium refiner of scraps containing Gold, Silver, Platinum and Palladium sourced from the jewellery and dental industries, and Gold and Silver derived from the Gold miner, producer and prospector.

Refining Descriptions

Jewellers High Grade Scraps

Scrap Gold

This description will be used to describe material that is predominantly or completely made up of old and/or broken pieces of Gold jewellery and still bears a resemblance to the original article. Scrap Gold also includes off-cuts, semi-worked Gold wire and sheet that may be often found in conjunction with scrapped out jewellery.

Gold Lemel

The word lemel is of French origin and translated it means “metal filings”. Lemel is typically quite dense and often greyish in colouring because of the abrasive compounds used in finishing jewellery. Lemel often contains a few broken pieces of jewellery and off-cuts from partially worked Gold alloys in small proportions, but quite clearly the consistency of the material is dominated by precious metal filings which can be as high as or even greater than 90% by weight.

Gold Scrap & Lemel

If the material is mixed, then Gold Scrap and Lemel is used when the majority of the incoming material is scrap, but a recognisable degree of lemel is also present. Occasionally a small number of saw blades or emery paper may be present, but largely this material is devoid of these contaminants.

Gold Lemel & Scrap

If the material is mixed then the Gold Lemel and Scrap description is used when the majority of the incoming material is lemel, but a reasonable degree of scrap is also present.

Ingotted Scrap Gold

Where the customer has melted and cast the material into an ingot (however rough), we use the term Ingotted Scrap Gold to describe it. This material however, is usually derived from melting down jewellery scraps and is not to be confused with Ingotted Native Gold (refer to description).

On most occasions the paler colour of the ingot would indicate its much lower caratage, that is the presence of Copper, Silver and other base metals.

Silver Scrap

This description will be used to describe material that is predominantly or completely made up of old and/or broken pieces of Silver jewellery and still bears a resemblance to the original article. Silver scrap also includes off-cuts, semi-worked Sterling Silver or Fine Silver wire and sheet often found in conjunction with scrapped out jewellery.

Silver Lemel

Silver Lemel is typically quite dense but noticeably less dense than a Gold lemel. It is typically greyish, the whiteness of the metal often becomes dulled due to oxidisation and contamination by Carborundum.

Silver Scrap & Lemel

If the material is a mixture of both filings and solid metal pieces, then Silver Scrap and Lemel is used when the majority of the incoming material is scrap, but a recognisable degree of lemel is also present.

Silver Lemel & Scrap

If the material is a mixture of both filings and solid pieces, then Silver Lemel and Scrap is used when the majority of the incoming material is lemel, but a recognisable degree of scrap is also present.

Ingotted Scrap Silver

This describes a single solid mass of metal that the customer has melted and cast into an ingot (however rough).

Jewellers Medium Grade Scraps

Gold Casting Scrap

This description will be used when describing material that consists of Gold metal in casting buttons, trees, damaged castings, granules and/or "spilt" solid metal form that may be accompanied by broken pieces of crucible or other ceramic or carbon debris associated with casting metals.

Silver Casting Scrap

This description will be used when describing material that consists of Silver metal in casting buttons, trees, damaged castings, granules and/or "spilt" solid metal form that may be accompanied by broken pieces of crucible or other ceramic or carbon debris associated with casting metals.

Jewellers Low Grade Scraps

Bench Sweeps

Bench sweeps, as the name would suggest, originates from the workbench of a manufacturing jeweller or hobbyist. Essentially, the material is a low grade lemel containing a small quantity of lemel, emery papers, saw blades, polishing wheels, and on occasion possibly a few small fragments/off-cuts of jewellery or working metals. The volume would be relatively small compared with a floor sweep but not as dense as a lemel or scrap Gold job. Typically, a bench sweep could be considered a low-grade lemel/scrap or scrap/lemel or a higher grade of floor sweep.

Floor Sweeps

This material is low grade waste swept from the workshop floor, hence the name. It usually contains dust, bits of emery paper, some polishing fluff, old mops, small amounts of lemel, and some off-cuts of precious metal that have dislodged from the jeweller's bench. Many jewellers use their floor sweeps as a bin for anything they feel could possibly contain any precious metals. As a consequence, a complete description is impossible as this material varies greatly from workshop to workshop. As would be expected, floor sweeps will contain dirt and are often contaminated with bottle tops, cigarette butts, waste paper.

Polishing Waste

This material is typically of high volume and low precious metal yield. The industry is more frequently adopting the use of extraction units that collect the fine dust particles of jewellery alloys which are generated, when polishing jewellery. Often this material is included in jeweller's floor sweeps though more commonly it is being kept separate and refined as an individual job.

Sludge Wastes (Wet/Dry)

This material is another low Gold yielding bi-product of jewellery manufacture. Collected in traps these wastes are essentially soap sediments collected from sinks and any liquid based cleaning or polishing operation. They may contain fine particles of filings generated during the finishing of jewellery. Typically, they are grey clay-like substances and should be semi-dried or dried when initially receipted.

Emery Paper

Some jewellers prefer to store and keep their emery papers or emery sticks separate from their other low grade wastes. This material contains relatively small amounts of precious metals and therefore a considerable quantity is required to warrant refining separately.

Floor Coverings

Over a period of time carpet and carpet tiles which have been laid close to a jewellers workshop will gather and trap fine particles of precious metals. Similarly vinyl and vinyl-like flooring used in workshops will tend to get filings and small pieces of precious metals imbedded in them particularly in areas where chairs with rollers are used.

Dental Scraps

Dental Gold Scraps

Dental scraps containing Gold, Silver, Platinum and Palladium can be refined in the form of old crowns and bridges or fillings etc. Silver Amalgams should not be included with your dental scrap.

Native & Mines Gold

Nuggets & Alluvial Gold

The word "native" means "innate" or "natural", and thus the description is used to describe Gold in its natural or "native" state. Gold in its native state would occur as nuggets or as alluvial deposits (flowery consistency, powdered or flaky). The colour is very typical for Native Golds, nuggets tending to be a rich yellow and alluvial Gold a golden brown in appearance.

Ingotted Native Gold

If the customer has melted and cast Native Gold into an ingot, then it is described as Ingotted Native Gold. The metal is usually easy to identify because of its bright rich golden yellow colour, the cleanliness of the surface of the ingot is because of little or no oxidisation and its density. Native gold usually contains 80% or more Fine Gold, hence the density and rich colour.

Sorting your scrap

Sorting your Scrap

How you prepare your precious metal scraps for refining can have an effect on the charges incurred for both assaying and refining. Your scraps are very valuable and correct sorting into appropriate grades or categories not only minimises assay and refining fees, it helps reduce the refining time and maximises your return.

Listed under "Refining Descriptions" are the main scrap categories found in the jewellery industry, the dental industry, and those from the miner, producer and prospector.

These descriptions (and others) will appear on the Metal Receipt you will receive from our Refining Department.

Maximising your Return

- **Segregate your scraps.** Keep the higher grades, such as lemel or scrap Gold, separate from your lower grades, such as floor sweeps, emery papers and polishing fluff. The recovery costs per gram is more efficient on these higher-grade scraps, thus your return is maximised.
- **Identify clearly the scrap you send.** Understanding the proportions of each carat that makes up your refining consignment. This is the only way to determine an approximate return without incurring a cost. Alternatively, if you have a melting facility, sample your material, being very careful that the metal has been completely mixed in the molten state. Take a drill sample from a number of locations on your ingot and have these independently assayed.
- **Do not mix types of alloys.** That is, try not to mix Gold alloys with Silver or with Platinum. Collect as much as you can for each consignment. Not only employ all the techniques at your disposal to trap precious metals in any form in your workshop, also collect and refine larger rather than smaller lots. This again effectively maximises your return.
- **We do not recommend you try to burn your own low-grade waste.** A good refiner will have a slow combustion furnace to burn down your low-grade waste. These furnaces effectively ensure that no minute particles of Gold are lost in the turbulent action of smoke discharge and the use of naked flames. This smoke transportation of microscopic Gold particles can be responsible for large percentage losses in a low-grade job. The potential cost saving made by reducing the total weight of your lot may in fact be excessively offset by Gold losses.
- **Screen your scrap.** Remove as much foreign material as you can. Saw blades, pins and broken tools only add to your refining costs. Iron can be removed by simply using a magnet. The cleaner the consignment, the more accurate you can estimate the melted weight, and thus approximate not only the Gold return, but also the refining charges.

Shipping

How to Ship your Refining

We offer convenient free of charge screw top lemel jars and cardboard cartons to contain your precious metal waste. When your refining is ready for collection our friendly Precious Metal Services staff will arrange for it to be collected and you will benefit from our excellent commercial freight rates. In most cases, when we arrange collection of your refining it will be fully insured while in transit. Please check with our Customer Service staff regarding any special conditions that may apply.

Please use discretion when filling out freight labels, the contents of your package should have an ambiguous description such as "metal components" so as not to draw attention to your consignment.

Once packaged, please clearly mark the delivery address as follows:

ATTENTION: PMS CUSTOMER SERVICE
PETER W BECK PTY LTD
14 DUNCAN COURT
OTTOWAY PARK
SOUTH AUSTRALIA 5013

High Grade Scrap

Airfreight deliveries are the most expedient way to transport your high grade refining.

The plastic lemel jars supplied by Peter W Beck Pty Ltd are a very secure and convenient way to send high grade waste. Simply tape the lid closed, place in a Jiffy bag or box and call to arrange collection.

If you prefer your own packaging it is important to ensure the consignment is securely packaged and correctly labelled. Avoid the use of zip lock bags as they have a tendency to open in transit. Do not use adhesive tape on plastic bags as this often makes your parcels difficult to open and Gold particles may adhere to it. A proper weight cannot be determined if the scrap cannot be separated from its packaging.

The best technique is to package your scrap in two heavy bags sealing each individual bag, one inside the other with a twist tie. These should then be securely packaged into a tight fitting box so that the packaged scrap is unable to move. Any movement within the box may cause the plastic to get punctured by sharp metal protrusions in your scrap and a possible result in weight loss.

Low Grade Scrap

Low grade wastes are best sent road freight and packaged in our free of charge corrugated cardboard cartons.

Place all sweeps into the heavy-duty garbage bag supplied, two bags may be necessary. Limit the weight to no more than 5kg per garbage bag. However, more than one bag can be placed in each box. Total weight must be limited to a maximum of 20kg for handling.

Seal the box with strong packaging tape. Ideally use fibre tape to secure the box and be sure to tape any open seams.

Instructions

A refining form will be sent with your containers, please include the completed form with your package or a Letter of Instruction. Your Letter of Instruction should include which metals you wish us to search for, how you wish the settlement to be made, and most importantly, your contact details must be included. By returning this completed form with your refining you will be giving us clear instruction as to how you wish us to process your consignment.

Refining Process

Peter W Beck Precious Metal Services®

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Web www.pwbeck.com.au

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Weighing

Receipting your Refining

Peter W Beck Pty Ltd recognises the need for accuracy. Upon receipt of your refining, our trained staff immediately weigh, check and categorise your material. All incoming weights are double checked and signed for, leaving no room for error. Our specialised computer programme will monitor and track your refining from weighing in through to payout.

A full detailed Refining Receipt will be faxed or posted to you.

Any discrepancies between our weights and descriptions, and those of our customer, are clarified at this point before the refining procedure is started.

Low grade reduction

Preparing 'Low Grade' Waste for Melting

Before attempting to recover the Gold, Silver, Platinum and Palladium, all refining jobs are sorted for their appropriate preparation.

Low grade material such as floor sweeps, carpet, polishing waste and hand wash waste must firstly be incinerated in a controlled environment to remove organic matter and yet leave behind the finely disposed particles of precious metal for further melting, fluxing and treatment.

After incineration, the sweeps and other low grade materials are then ground to a fine powder and flux is added before entering the melting cycle.

Sampling

Melting & Sampling

After preparation and inspection, all incoming refining material is melted and sampled. Care is taken to ensure the correct type of flux and mould types are used. Low grade material requires the use of conical moulds to ensure the complete collection of metal and to minimise or eliminate metal retention in the flux. Higher grade materials require less flux and an open skillet type mould will be selected.

Peter W Beck Pty Ltd utilises different melting equipment from gas fired to medium frequency furnaces to ensure the resultant ingot is clean, flux free and homogenous. Sampling is a critical part of the refining process and it is crucial to follow a procedure that guarantees a truly representative sample. To achieve this aim, we use the dip method in which we draw a sample from your metal whilst it is in a completely molten and homogeneous state.

Assaying

Assaying

Assaying is essentially the science of determining the percentage of Gold, Silver, Platinum and Palladium present in the sample.

Given that accuracy is so important when determining the precious metal content of your refining, we use two assay tests, Fire Assay and Atomic Absorption Spectrometry.

Fire Assay

Fire Assay, also known as cupellation, is when a precious metal sample which has been wrapped in Lead foil is placed in a crucible (cupel) and then heated in a high temperature oven. In the oven the base metals oxidise and are drawn into the cupel leaving only the precious metals behind, the Gold and Silver can then be separated. By weighing the sample before and after cupellation it is possible to determine the percentages of its constituents.

AAS Assay

Assaying by Atomic Absorption Spectrometry (AAS) is achieved by spraying a dissolved sample through a flame to measure the absorption of metal ions.

In this elemental form, metals will absorb ultraviolet light when they are excited by heat. Each metal has a characteristic wavelength that will be absorbed. The AAS instrument looks for a particular metal by focusing a beam of UV light at a specific wavelength through a flame that contains the dissolved and aspirated sample and finally into a detector. If that metal is present in the sample, it will absorb some of the light, therefore reducing its intensity which the instrument can measure. A computer data system converts the change in intensity into an absorbance value which can then be measured against known values.

After double checking the determination for accuracy, the assay results are entered directly into the computer system which ensures the results are allocated to the appropriate refining job which is now ready for the refining cycle and payout.

Processing

The Refining Cycle

We understand refining and its value to you. That is why we incorporate strict checking systems and employ the best equipment and experienced staff that are familiar with the unique requirements associated with every refining job.

Only after receipting, preparation, melting, sampling and assaying is the refining job committed to the refining process. Our technicians are well trained in the wet chemical and electro winning techniques that we employ to check and monitor the refining process for the complete recovery of Gold, Silver, Platinum and Palladium.

All return results are logged into our specialised computer programme and cross-checked to ensure the integrity of the refinery cycle, which results in maximum and consistent payouts to the customer.

Return

Settlement

Settlement or payout of the complete refining job is available in a variety of ways and can be tailored to suit the customer's requirements.

Whether you prefer your return to be in metal or you would like us to purchase your return we are happy to accommodate. Fine Gold, Silver, Platinum and Palladium can be returned. Gold and Silver can be cast into investment ingots, alternatively you can have your metal returned as carated alloy.
If you prefer we can purchase your return and either credit your trading account, deposit the funds directly into your bank account or supply you with a cheque.
The payout price is automatically set for the day the processing is finished or if you notify us prior to weighing you can choose to set the payout rate for the day we receive your refining.
Combinations of the above settlement methods are available and should be discussed with our Customer Service team.

At the completion of each refining job a settlement statement (Transaction Summary) is sent to the customer, this statement fully details the history and settlement details. The statement includes date received, settlement date, material description, incoming weight, final weight, percentage and total weight of Gold, Silver, Platinum and Palladium due for settlement, the payout price and the payout date chosen by the customer, which may be either the date of receipt or the day of settlement, along with all assay and refining fees.

Refining Services

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Services

Express Payout Service

An Express Payout Service is available for an additional charge which reduces the turnaround time to four working days. The Express Payout Service is only available for high grade Gold scraps and Native Gold jobs and will only be assayed for Gold and Silver. This service is for payment only and no metal can be returned if this option is chosen. Platinum and Palladium refining cannot be treated as Express. For more details about this service please contact our Customer Service team.

Assaying Service

Assaying of Gold, Silver, Platinum and Palladium is also offered as an independent service. This service can be used if you want to determine the carat of jewellery pieces or Native Gold Nuggets etc. A small sample of between 2gm to 5gm is required for this service. The remainder of your sample will not be returned. We will provide an Assay Report of the results.

Packaging and Freight Collection Service

We can supply you with lemel jars and low grade cartons. When you are ready to have your refining processed, simply contact our Customer Service team to arrange fully insured* collection of your consignment.

*Conditions apply see "SHIPPING" on Page 97.

Customer Service

Whether your query is related to jewellery waste, prospecting or mining our friendly Customer Service team will be able to help you quickly and efficiently.

Our Customer Service consultants will happily discuss with you any questions you may have regarding your refining. We can help you with job tracking, quotations, product information or general enquiries.

We can also send to you our scrap & lemel jars or cartons for low grade waste.

Toll free: 1800 888 590

Telephone: 08 8440 3399

Facsimile: 08 8447 1144

Email: preciousmetals@pwbeck.com.au

We can assure you that you will receive our best service and attention at all times.

rication alloys casting refining assaying gold silver platinum palladium wire she
d rhodium plating solutions master alloys fabrication alloys casting refining ass
ladium wire sheet solder granules chenier gold rhodium plating solutions mast
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Technical Information

Peter W Beck Precious Metal Services®

Toll Free 1800 888 590
Telephone 08 8440 3399
Facsimile 08 8447 1144
Email preciousmetals@pwbeck.com.au
Web www.pwbeck.com.au

Technical Information Index

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Toll Free 1800 888 590
Telephone 08 8440 3399
Facsimile 08 8447 1144
Email preciousmetals@pwbeck.com.au
Web www.pwbeck.com.au

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The Staff at Peter W Beck Pty Ltd

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About Gold

About Precious Metals

The precious metal family comprises Gold, Silver and the six Platinum group metals. In the jewellery industry, Gold, Silver, Platinum and Palladium are used commonly in combination with each other and with base metals to produce alloys with specific properties that make them suitable for jewellery making. Any metal on its own, in its purest form, is called an 'element'. An alloy is a mixture of two or more pure metals. In the case of Gold alloys, the amount of Gold used alters the carat rating of the alloy.

Gold is the softest and most malleable of the precious metal family and is the most ductile of all metals, although it is harder than Tin. As a pure metal, it is too soft for most jewellery applications and must be alloyed with other metals to give it strength and durability. The alloying of Pure Gold with other suitable metals in the correct proportions enables the jewellery industry to produce alloys with the desired mechanical properties and colour.

Usually base metals are added to improve hardness and alter the colour. Other effects of adding such metals include corrosion resistance, castability, improved grain structure, workability, tensile strength and a desired melting range.

Metals Used

The other main elements used when alloying carated Golds include Platinum, Palladium, Nickel, Zinc, Cadmium, Ruthenium as well as Copper and Silver. Fine Gold is a very rich yellow in colour. The more Silver and other white/grey elements added the paler the colour becomes. The more Copper added the more red it becomes. Varying the Copper/Silver ratio for a given carat will, therefore, change the colour from red through pink/rose to yellow and pale yellow. The alloys with a lower Gold content provide the greatest scope for colour variations. Gold can be made white by adding the white/grey metals, for example, Silver, Platinum, Palladium and Nickel, all these metals are particularly good bleachers of Gold, although Silver alone will whiten the low carat Golds.

Different working characteristics can also be obtained by adding different elements. For example, Nickel is hard with a high melting point and makes very hard, durable white Gold jewellery. Whereas Platinum and Palladium will impart less springiness and strength but are good for making white Gold ring settings because the claws will exhibit low tensile strength and remain bent when pushed over to hold a stone in place.

Rhodium, Iridium and Ruthenium which are members of the Platinum group are also used throughout the world in jewellery alloys in combination with other precious and base metals. The addition of Iridium or Ruthenium in small amounts will affect the working characteristics by controlling the grain size of the final alloy. Rhodium is used to electroplate a white hard metal finish onto jewellery alloys, providing protection to the surface of soft alloys and changing the colour to a bright white.

Metals most commonly used and alloyed with Fine Gold in the jewellery industry are:

Element	Chemical Symbol	Colour Effect
Copper	Cu	Reddening
Silver	Ag	Greening/Whitening
Zinc	Zn	Whitening
Nickel	Ni	Whitening
Palladium	Pd	Whitening
Platinum	Pt	Whitening

Examples of the different resultant colours due to alloy composition are:

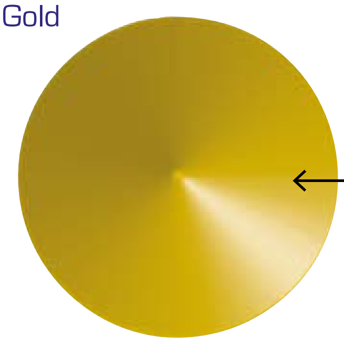
Colour	Composition
Yellow	Gold, Silver, Copper, Zinc
White	Gold, Silver, Platinum, Palladium, Nickel, Copper, Zinc
Red	Gold, Copper
Green	Gold, Silver

The addition of each metal has a different effect on the final properties of the alloy. Knowing the characteristics of these metals and understanding their effects is an important skill when selecting the most appropriate alloy to use. In chain manufacturing, for example, the wire undergoes extensive drawing and deformation and so needs high ductility to withstand the elongation and cold working without fracturing. To make shepherds hooks for earrings, the wire needs to remain springy and thus must have high tensile strength (the force required to permanently bend the wire is high). Both applications require the alloy constituents to be chosen carefully in order to achieve the desired working properties. It is for this reason that specialised alloys are developed in the industry. Setting alloys are another good example of an alloy developed for a specific application.

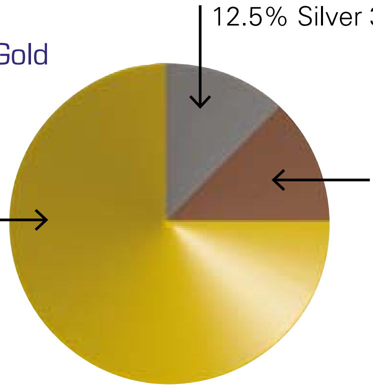
Carat

There are two ways of describing the Gold content of a carated Gold. One is the fineness scale which gives the Gold content in parts per thousand and ranges from 0 to 1000. Pure or Fine Gold is known as 999.9 (four nines Gold), 18 carat as 750 and 9 carat as 375. The other way to describe Gold content is the carat scale which has been in use since ancient times. Carat comes from the Italian word Carato and the Arab word Quirat which means the fruit of the carob tree. The seeds from the fruit of the carob tree were all very even in weight and were used to balance the scales when weighing Fine Gold in ancient market places. The carat scale ranges from 0 - 24. Fine Gold is 24 carat, 750 fine is 18 carat or 18/24ths and 375 fine is 9 carat or 9/24ths. A basic formula for 18ct yellow Gold would contain 75% Gold 12.5% Silver and 12.5% Copper. A 9ct yellow Gold would contain 37.5% Gold 15% Silver and 47.5% Copper.

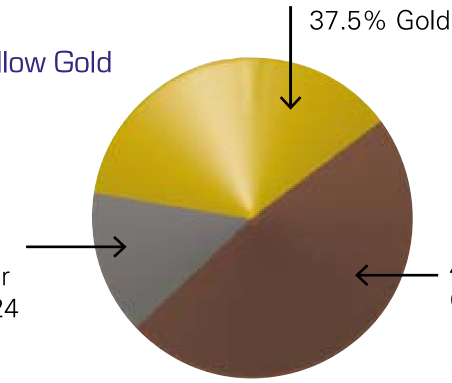
24ct Yellow Gold



18ct Yellow Gold



9ct Yellow Gold



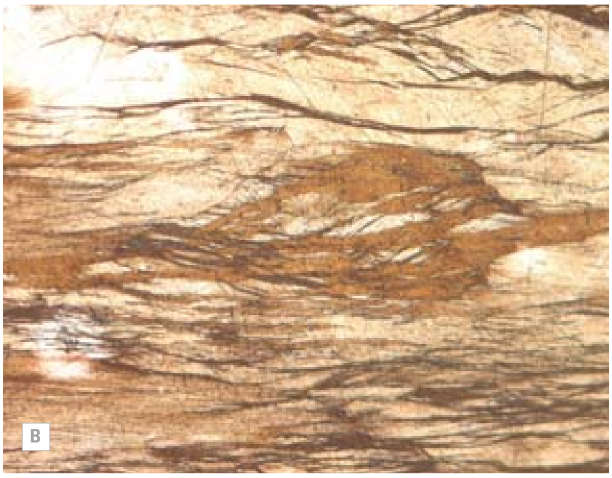
Annealing

A 22CT YELLOW SAMPLE "AS CAST" SHOWING LARGE CRYSTAL STRUCTURE.

B 22CT YELLOW SAMPLE "COLD WORKED" TO A 70% REDUCTION SHOWING ELONGATED CRYSTAL PLANES.

C 22CT YELLOW SAMPLE AFTER ANNEALING. THIS HIGHLIGHTS THE RECRYSTALLISATION OF THE GRAIN STRUCTURE.


A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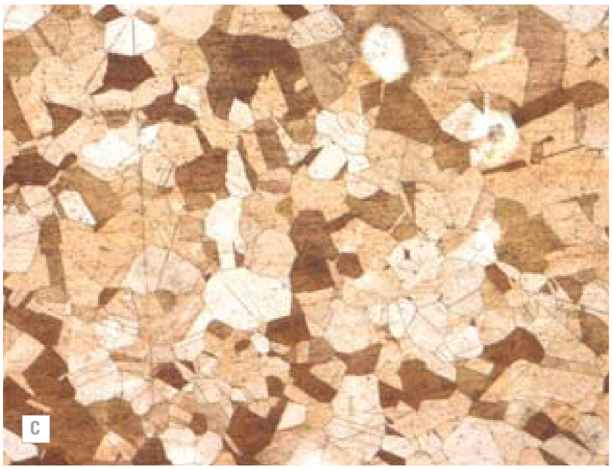

C

Annealing is the process of restoring a metal to a soft ductile condition after it has been work hardened. Heating the metal to an optimum annealing temperature allows the metal to recrystallise without deforming to the original shape.

Why Annealing is Necessary

When a metal or alloy solidifies after casting, the atoms come together in small clusters to form tiny crystals, a process called nucleation, these then grow until all the liquid metal has solidified. As a result metals and alloys are composed of many crystals (i.e. they are polycrystalline), which metallurgists call 'grains'. The boundaries between the crystals or grains are called 'grain boundaries'. The grain size of cast metals can vary, depending on casting conditions and the alloy composition.

Large grain sizes are undesirable. The smaller the grains, the more ductile the metal behaves. As the metal is worked, each grain becomes deformed or elongated to accommodate the overall shape change. Deformation within each grain is the result of crystal planes sliding over each other in a complex manner; with each subsequent sliding requiring more force (this requirement to exert increasing amounts of force is known as work hardening). The crystal structure becomes more distorted, until the planes are no longer able to slide. The structure now becomes locked and any further working causes fatigue and metal failure, exhibited by fracturing and cracking.

At this point of extreme work hardening, the metal strength and hardness are at a high level and ductility is low. If further working is to be done, there is a need to restore ductility and softness which can be accomplished by annealing.

Annealing at relatively low temperatures has little effect on the properties. However, if the annealing temperature is raised sufficiently, over a period of time, the strength and hardness will fall to a low level and the ductility is restored to a high level. This is achieved by the process of recrystallisation, which will see the damaged crystal structure healing itself by nucleation and the growth of new crystals.

Over-heating (or heating for too long), however, will lead to an excessively large grain size, which results in the 'orange peel effect' on the metals surface and possible failure during further working. Overheating may also lead to other problems due to oxidation of base metals within the alloy, for example, firescale in Silver alloys.

It is therefore critically important to pay close attention to the annealing process by ensuring the correct temperatures are used and oxide prevention techniques are followed.

Annealing should only be carried out on work hardened metals. Low levels of cold working will leave a large grain size, whereas an appropriate amount of cold working, correct annealing temperatures and time followed by the correct quenching technique will lead to a more desirable smaller grain size.

When to Anneal

A metal must be hard worked prior to annealing. It is generally considered that a cast ingot should be reduced in cross section by a minimum of 50% before annealing for the first time. After this first anneal it is recommended the metal be further hard worked by between 50% and 70% before any subsequent anneals, for most Gold alloys a reduction of 60% to 65% is considered correct.

To calculate the percentage reduction of your metal we need to calculate the end section square area before and after cold working. This can be expressed by using the following formula:

$$\frac{\left(\text{Starting End Section Square Area} - \text{Finishing End Section Square Area}\right)}{\text{Starting End Section Square Area}} \times 100 = \%\ \text{reduction}$$

For example: a length of round wire starts at 10mm diameter and is drawn down to 5mm diameter. *(The area of a circle is calculated by* ***diameter squared × 0.7854****).*

$$\frac{(78.54 - 19.635)}{78.54} \times 100 = 75\%\ \text{reduction}$$

A piece of sheet that starts at say 100mm wide × 5mm thick and is rolled down to 100mm wide × 2.5mm thick.

$$\frac{(500 - 250)}{500} \times 100 = 50\%\ \text{reduction}$$

How to Anneal

Kiln Annealing

The most effective method for annealing is in a controlled atmosphere kiln in which inert gasses such as Nitrogen and Argon exclude Oxygen in the heating chamber. The metal being annealed is thus free from oxidation. Most professional alloy suppliers utilise this approach because it both protects the alloy from oxidation and allows complete control over the temperature and duration of the annealing process.

Step By Step Procedures

1. Ultrasonically clean the parts to be annealed in a degreasing solution, rinse well with clean water and dry;
2. Preheat the kiln to the required temperature (See Alloy Tables for ideal annealing temperatures);
3. Place the parts in the kiln for the appropriate length of time as indicated by the following guide:

Approximate Quenching Times & Quenching Techniques

Kiln anneal for:

A. 30 minutes, quench immediately
B. 30 minutes, cool until slight red glow, quench
C. 30 minutes, air cool on steel plate
D. 10 minutes, quench immediately
E. 1 minute/mm of thickness, quench immediately

4. Quench in clean demineralised water and remove oxides by placing in a pickle bath if the kiln does not have a protective atmosphere. Be careful to use the correct quenching technique from the above guide.
5. The parts are now softened and ready for further processing.

Please note that annealing temperatures relate directly to the alloy and annealing times relate to the mass of the piece or pieces to be annealed. As a consequence, some experimentation may be needed to arrive at the optimum annealing time or times for your individual requirements.

Torch Annealing

When annealing at the workbench we must take into account the same concerns involved with kiln annealing and best try to replicate the parameters in order to obtain acceptable results. Without the benefits of a protective atmosphere provided by a professional kiln we should protect the metal from oxidation using a flux. We suggest a mixture of Ethanol (Methylated Spirits) and Boric Acid as a protective flux. While helping to protect the alloy from oxidation, this technique won't eliminate oxidation entirely.

Controlling the temperature, duration and maintaining constant heat are critical. Smaller items will be easier to control at the bench as the need to move the heat source to cover the entire piece is eliminated. Wire should be coiled to present a smaller area, strip and sheet needs to be heated evenly by moving the heat source back and forth over the length and width of the piece. As mentioned previously, heating below the recrystallisation temperature will not soften the metal regardless of the duration, and over heating will cause brittleness and damage to the alloy. Uneven heating is also to be avoided as it will create a piece of varying hardness.

When heated above the recrystallisation temperature, time and temperature are, to some extent, interchangeable. The higher temperatures that are typically reached by torch annealing generally require shorter annealing times.

The most critical part of torch/bench annealing is the ability to judge the temperature of the alloy and ensuring it is uniform. Equating the metal temperature with the colour of the heated metal provides a good approximation of this. An even colour will indicate even heating, ensuring that the recrystallisation is both complete and the grain boundaries/sizes are even throughout the piece. Below is a table to help you approximate the required annealing temperatures of alloys by judging the colour of the heated alloy. It is important to view this process away from direct sunlight and preferable under light conditions that are semi shadow and consistent.

Equating Colour with Temperature

Alloy	Annealing Temp °C	Colour
24 Carat (fine)	200	Black heat
22 Carat	550-600	Very dark red
18 Carat	550-600	Very dark red
9 Carat	650	Dark red
White Gold (Pd)	650-700	Dull cherry red
White Gold (Ni)	700-750	Cherry red
Stg Silver	600-650	Dark red
Platinum	1000	Red - orange

Step By Step Procedures

1. Ultrasonically clean the parts to be annealed in a degreasing solution, rinse well with clean water and dry.
2. Coat the part in a solution, which is made by dissolving Boric Acid powder in Methylated Spirits. Use only the clear solution. Allow the piece to dry; a white haze should coat the surface.
3. Using a naturally aspirated LPG hand torch, heat the part on a refractory block (fire brick) slowly and evenly until the entire piece is the appropriate colour. It is essential to conduct this operation in a dimly lit room.
4. Having firstly identified the correct quenching technique from the alloy tables, quench in clean demineralised water and remove any oxides by placing in a pickle bath.
5. Wash the parts well in running water and dry. The parts are now in a softened state ready for further processing.

Quenching Techniques

Quenching after annealing ensures the metal keeps its soft and ductile structure by setting the grain size while it is small.

It is important to note however that alloys with a high Copper content are susceptible to age hardening if allowed to excessively cool down after annealing or soldering and before quenching. This applies particularly to all the red, pink and rose coloured Golds. These alloys must be quenched immediately after annealing or soldering to prevent age hardening, which if left unchecked will lead to a brittle and unworkable piece that will be prone to cracking and, in extreme cases, the metal will crumble when worked.

White Golds with a Nickel content however must be treated completely differently. After annealing or soldering they should be allowed to air cool on a steel plate until it is safe to touch, quenching and pickling will now leave a clean and workable piece.

To assist with the correct annealing and quenching techniques for any particular alloy please refer to the Fabrication Alloys Tables and the following guide:

A. Quench immediately
B. Cool until a slight red glow then quench
C. Air cool on a steel plate
D. Quench immediately
E. Quench immediately

Pickling

If you are not able to anneal under a controlled atmosphere it is probable that your annealed piece will have a discoloured oxide coating. The piece must finally be placed into a pickle bath to remove any oxide contamination. This removal is achieved by placing the part in a hot "Safety Pickle" solution, which can be purchased commercially or made by dissolving Sodium Bisulphate in water. An alternative to "Safety Pickle" is a mixture of 10% Sulphuric Acid and water.

When preparing acid solutions ***always add the acid to the water, wear protective glasses****, and appropriate hand and personal protection.*

In conclusion, it is important to note that not all alloys behave the same way. Different annealing and fabricating techniques may need to be employed even though the alloys may be the same colour and carat.

Casting

Introduction

Investment – or Lost Wax – casting of precious metals dates back over 4,000 years, being used by several ancient civilisations. As a jewellery manufacturing technology, it was rediscovered some 50 years ago and has reached a high level of development in recent years.

Lost wax casting is simple in concept but practicing it successfully is much more difficult. The process is complex and castings are prone to various defects, leading to poor productivity and higher costs. There is a tendency for casters to focus on the melting and casting stages, but defective or unsatisfactory castings are often caused by improper execution of one or more of the preceding stages of the process.

Casting Alloys

Some carat Golds for casting are specialised alloys designed specifically to meet the requirements placed on them. They contain special alloying additions to ensure effective deoxidation, grain refinement, fluidity during casting and good mould filling, as well as the usual requirements of carat conformance, colour, hardness, strength and ductility.

Casting alloys can contain additions such as Zinc and grain refiners such as Iridium usually in very small and controlled amounts. If however, these additions are in excess, the casting alloys will become brittle and display a tendency to crack.

The Process

There can be in excess of 13 separate stages involved in investment casting:

1. Design
2. Make the master model
3. Make rubber mould
4. Make wax patterns from rubber mould
5. Assemble wax patterns into 'tree' around central sprue
6. Make investment mould: Fill flask containing tree with liquid investment slurry, allow to set
7. Dewax mould/flask
8. Burnout mould
9. Melt alloy in crucible
10. Cast into hot flask
11. Remove investment material
12. Cut castings off tree
13. Assemble and polish finished jewellery

It is essential for each stage to be performed correctly. Failure to do so will invariably lead to poor quality castings. Getting the right blend of materials, equipment and conditions is not an easy task.

The critical aspects of each stage will be highlighted in the following:

Making the Master Model

The model designer should have practical workshop experience of the whole casting process.

The model should preferably be made in a hard metal, such as Nickel Silver, although other metals and wax or plastics are used, particularly if produced by CAD and Rapid Prototyping techniques. Sterling Silver is commonly used, but Sterling Silver masters should be Rhodium plated to avoid a reaction during vulcanising between the Silver and the rubber mould. Silver reacts with the Sulphur which is present in the vulcanising rubber.

A good surface finish is important and will save much polishing of the cast items made from it. The gate/feed sprue should be carefully positioned and be of adequate size to feed the casting during solidification. If it freezes first, then the casting will suffer from shrinkage porosity. As a rule of thumb, the feed sprue should be of diameter at least equal to the cross-section it is feeding. Tapering of gates should be avoided. Many incomplete fills or shrinkage problems are attributable to inadequate gating and sprueing.

Making the Rubber Mould

Good quality rubber moulds are essential for good casting. There are many moulding rubbers available, including natural and synthetic rubbers, Silicone rubbers and cold curing materials. Each grade has different properties and is used in different situations. Some are more durable and flexible and less likely to crack and distort the wax on removal. Others may be harder and better reproduce highly polished surfaces, but may be less durable and prone to crack more easily. Seek advice from your supplier as to the preferred grade to use for particular applications.

Allowance must be made for shrinkage of some rubbers in the master model dimensions, although non-shrink rubbers are available.

Silicone moulds give good surface reproduction and wax patterns are easier to extract. They are more prone to cracking and can hinder escape of air during wax injection. This can be overcome by cutting vents in the mould.

The master model is placed between sheets of rubber in a mould frame and then cured and vulcanised by a combination of heat and pressure in a vulcanising press. There is an optimum temperature for vulcanisation: for conventional rubber this is typically about 158°C and within a range of 143°C - 173°C. The optimum temperature depends on the rubber used and the manufacturer's recommendations should always be followed. The time at temperature depends on mould rubber thickness, e.g. 12 minutes for 12mm thick to 75 minutes at 36mm thick.

After vulcanising, the rubber mould should be cut with a sharp scalpel into two matching halves and the master model removed. There should be sharp undulations or keys to ensure the two halves register exactly during use. Avoid separation lines on the main surfaces of the waxes; this will avoid excessive finishing time when cleaning up the castings. Cutting of moulds requires a high level of skill and patience.

Making Wax Patterns

It is important to use a good quality wax with a narrow melting range for good results. Again there are different grades available, each with properties suited for different applications. Some are softer and more flexible than others. Where a highly polished surface is needed, a harder wax may be preferred. If you experience problems, ask your wax supplier for advice on appropriate grades. It is unlikely that one wax will meet all the needs in a casting facility.

Hot, molten wax is injected into the rubber mould via a wax injector. A good wax injector should guarantee constant temperature and pressure. Modern vacuum wax injectors have auto clamp devices which control wax volume and weight. Inconsistent wax weights are often due to inconsistent (manual) clamping of the rubber mould during injection.

In many instances, the mould will be lightly dusted with talc or sprayed with a mould release agent prior to wax injection to aid subsequent wax removal. Overuse of talc will degrade the wax surface. Use of corn flour or starch is an alternative to talc and will burn out cleanly. Regular cleaning of moulds is important. Talc will accumulate in the corners and lead to poor waxes.

If you want quality castings, never recycle old defective waxes into the wax pot however, it is permissible to recycle clean wax for use as the central sprue. Wax degrades at temperature and picks up contaminates such as dust and talc. Wax from the de-wax operation should never be recycled.

Each mould should be coded uniquely to aid pattern identification. When not in use, moulds should be stored in dust free and dark conditions such as a drawer or cupboard. Rubber moulds will deteriorate when exposed to direct sunlight for long periods.

Moulds should be regularly inspected for signs of damage and discarded if necessary. It is a simple task to make a new rubber mould.

Assembling the Tree

Waxes should be carefully inspected before mounting on the central sprue. Defective ones should be discarded and new ones made. Repairing waxes is generally not cost effective.

The waxes are mounted on the central sprue using a wax gun. This can be done in the horizontal mode or at an incline or vertically, whatever is most comfortable. It is important to ensure a smooth weld, with no undercuts that can lead to breaking off of investment during casting. The angle of mounting is about 30° to 45° to the horizontal (tree vertical) for centrifugal casting but for static vacuum casting a lower angle of 10° to 20° is advised, this will assist in controlling the direction of solidification.

Do not mount waxes too close together and certainly not touching. The space between will be the investment thickness. If the investment is too thin, gas porosity and other defects are more likely to occur in the castings. Remember to weigh the whole wax tree to enable calculation of the metal charge needed for casting. Rubber bases should be separately weighed so the wax weight can be directly known. Multiply this weight by the alloy density to calculate the alloy weight. This is a rule of thumb and experience will show if adjustments are needed. Thus, you need to know the densities of the alloys you are casting.

Wax trees are prone to pick up dust due to static electricity. This can be removed by dipping the tree in commercial surfactants or dilute detergent solution, rinse in deionised water and allow to dry.

Investing the Tree to Make the Mould

The tree, with its rubber base, should be placed inside a clean metal flask which has had any old investment removed prior to reusing. If it is perforated, then a paper cylinder should be wrapped around and secured with masking tape to prevent leakage of the liquid investment.

The investment powder should be carefully weighed.

Note: Ensure that all operators wear properly fitting face masks as inhalation of ultra fine Silica powder during mixing and during quenching in water after casting can cause serious lung damage.

The correct amount of investment powder and water is weighed out, mixed to a smooth slurry and then degassed under vacuum. It is then poured into the prepared flask around the wax tree. There are investment mixing machines that do all this automatically.

It is most important to follow accurately the investment powder manufacturer's recommendations about mixing, working time and temperature. It is a safe rule to record the operating parameters. Always add the powder to the water and not the other way round. Check that the temperature of the water is in the range 20°C to 25°C. The use of deionised water is recommended. If the water temperature is too high, the setting time will be reduced and unnecessary complications can occur.

It is also important to measure the true working time of a batch of investment. A practical way is to measure the 'gloss time' or 'gloss off' time, that is the time elapsing between mixing and the 'gloss point', which is the moment when the surface of the slurry loses its gloss. It is at this moment the investment begins to set. It is a very similar process to the setting of cement. The binder takes up water of crystallisation and binds the Silica particles together.

To avoid defects such as watermarks and air bubbles adhering to the wax patterns, it is suggested that the flask is vibrated until one minute before the gloss point. Watermarks on castings are due to water that separates from the slurry and collects on the wax surface, forming vein-like markings on the mould surface. These veins are reproduced on the castings, and often make them unusable.

The investment mould is then allowed to set and harden. It should not be moved or subjected to any disturbances. Minimum setting times before

dewaxing are two hours for small flasks and five hours for large flasks. This is very important. Too often, casters do not give sufficient time before dewaxing and burn out.

Dewaxing

When the investment in the flask is set, the wax must be removed to leave a clear mould cavity for casting. It can be removed in two different ways either with steam prior to burn out or removed directly in the dry conditions in the burnout oven.

The first method which is used by some casters, but usually only in selected circumstances, is steam dewaxing. Research indicates that in dry dewaxing, some wax is absorbed into the surface of the investment. During subsequent burnout, this absorbed wax can leave carbonaceous residues that generate defects in the investment, mainly caused by Calcium Sulphate ($CaSO_4$) decomposition. These defects can give rise to problems in the castings like sandy surface and in the worst cases, gas porosity, which is very difficult, if not impossible, to polish out.

With steam dewaxing, the investment saturates with humidity, increasing wax surface tension and preventing it from entering the refractory. In this way, wax is removed more thoroughly and in a shorter time. Steam dewaxers are simple stainless steel boxes with an immersion heater in the bottom to boil the water and a perforated shelf above to hold the inverted flasks. Such equipment can be purchased, but can also be easily made in house.

Burn-out

The burn-out stage fires the investment to a hard refractory condition so that casting can take place. It is of great importance to follow the burnout cycle suggested by the investment manufacturer. Rate of heating and temperature control are critical. Also remember that the investment is a refractory ceramic with poor heat conduction. It takes time for the centre of the flask to reach the set temperature. That is why it is important to soak for two to three hours at each set temperature point.

In the heating phase there are two critical points. The first one is at 100°C to 120°C, when absorbed water and water of crystallisation in the Gypsum binder evaporate. This process is slow and the temperature must rise quite slowly. The second critical point is at 250°C, when beta (ß) Crystabolite phase of the Silica powder transforms into the alpha (α) Crystabolite phase. The transformation takes place with a volume increase; therefore, the temperature should be held constant at 250°C for some time, to let the transformation take place uniformly in the whole section of the material and to avoid the risk of cracking.

Lastly, the maximum temperature of 750°C must not be exceeded. At higher temperatures, the Calcium Sulphate binder ($CaSO_4$) can decompose, especially if carbonaceous residues are present. If Calcium Sulphate ($CaSO_4$) decomposition takes place during the burnout process, the defect induced in the casting is a sandy surface. If it takes place while pouring the molten alloy, the corresponding defect is gas porosity. On the other hand, a minimum temperature of 690°C is required to ensure complete burnout of Carbon from wax residues. The optimum maximum temperature is therefore 730°C for Gypsum bonded investment and it is vitally important that this is adhered to in practice. Consequently, temperature gradients in the burnout furnace must be avoided, and temperature measuring devices calibrated and checked at regular intervals.

To obtain temperature homogeneity in the flasks, rotary hearth ovens can be used, the flasks rotate within the burnout oven, and any temperature inhomogeneities are evened out. It is important not to overfill the burnout oven with too many flasks as this will result in variations in flask temperatures and hence in casting quality.

The final temperature of the flask before casting depends on flask size, type of casting machine and type of Gold alloy, and may have to be determined by experience.

If casting with gemstones in place, the burn-out cycle is modified to a maximum temperature of 630°C. There are special investment powders for this that helps to protect the stones during burnout. Again it is recommended following the investment manufacturers recommendations.

Melting

Every goldsmith is able to melt. Many goldsmiths succeed in producing very beautiful jewellery by making and melting their alloys in a gas torch-fired crucible. Pure Gold, Silver and base metal additives of the highest quality must be used if pre-alloyed material is not purchased in from a specialist alloy supplier.

Avoid putting oxidised or dirty materials in the crucible. If the oxide is not removed it will react with the Calcium Sulphate ($CaSO_4$) of the investment and will induce gas porosity in the castings. Furthermore if any scrap is being recycled e.g. central sprues and gates, it is essential to remove all traces of old investment. Ideally, all scrap should be separately melted and regranulated prior to recycling.

Considering that temperature is a critical parameter for defect formation, it is suggested that excessive overheating of the metal to be cast is avoided. Modern equipment allows successful casting at temperatures no higher than 100°C above the melting point (liquidus temperature). A superheat of 50°C to 75°C is preferred. Casting temperatures should be measured to ensure reproducibility on repeat melts.

If melting and casting must be done in air, it is recommended that melting and pouring be done as quickly and smoothly as possible. The surface of the melt should be protected from oxidation with a flux (e.g. Borax) or by charcoal lumps floating on the surface. These must be skimmed off before pouring.

Casting

Centrifugal Versus Static Casting

Each method has its own advantages and drawbacks. In recent years, thanks to vacuum assisted technology, there has been more technical progress in static casting. Moreover, static casting allows the use of larger flasks, enabling higher productivity to be obtained. It should be noted that some metals and alloys, in particular Platinum, have poor fluidity and to achieve good form filling, the use of centrifugal casting machines is preferred. For Gold jewellery, static vacuum casting is preferable and is increasingly being used, although many manufacturers continue to produce good castings on centrifugal machines.

It is important that pouring of the molten metal into the mould be carried out in the shortest possible time. As already mentioned in the introduction, in jewellery manufacturing where only small alloy quantities are involved, it is necessary to act quickly to reduce temperature losses. Temperature losses, if allowed, will impair the casting quality.

After casting, the flask should be allowed to cool for several minutes to ensure solidification is complete. It is then quenched in water to cool it to room temperature and to remove the bulk of the investment from the cast tree. This is also a hazardous step from a health and safety viewpoint as Silica particles can be released into the atmosphere. Face masks must be worn, unless quenching is done in a specially designed closed facility. The remaining investment can be removed by high pressure water jets.

Casting Equipment

There are many manufacturers of investment casting machines, each with a range of models to suit all requirements and budgets. These stem from simple bench top casters to complex computer controlled machines for mass manufacture on a large scale.


For the bench jeweller, casting can be done either with a simple jig to hold the hot flask whilst pouring of the melt by hand. Or as an alternative, a basic centrifugal casting machine can be used. These machines are powered by either a clockwork spring mechanism or by an electric motor. Also available are quite sophisticated static vacuum assist machines especially designed for operation on a small scale.

The more basic the approach, the less easy it is to ensure quality and consistency.

Common Defects in Casting and their Control

Misruns

A misrun is an incomplete filling of the mould during casting. The main causes are either that the mould (flask) temperature is too low or that the melt temperature is too low, in which case one or both of these temperatures has to be adjusted. Alternatively, it may be that the wax pattern is improperly gated, that is the gates are either too narrow or too long.

Watermarks

Watermarks on the surface of the casting indicate that the water has separated from the investment plaster before it has set. This is because the work time has been completed too early in relation to the setting time and this is affected by the water temperature. It is very important that the temperature of the water used for mixing with the powder is in the range recommended by the powder manufacturer so that the work time is completed only about $1\frac{1}{2}$ minutes before the initial set time. This is usually 20°C to 25°C. Furthermore, the mould/flask should not be moved until the investment is set as vibration can cause separation.

Fins and Poor Surfaces

Fins or flashing on the edges of castings or rough sandy surfaces are due to a weak or cracked investment. This problem has a number of possible causes:

- Either an incorrect water/powder ratio
- An overlong working time
- Insufficient standing time before dewaxing and burnout
- An incorrect burnout procedure
- Or it may be due to use of investment that has 'gone off' due to poor storage conditions or it has exceeded its 'use by' date

In Summary:

- The investment powder must be stored in moisture free conditions
- The water/powder ratio must be as specified by the powder manufacturer
- Ensure that the work time is of the correct length
- Avoid moving flasks before initial setting
- Allow 2 hours for small flasks and 5 hours for large flasks before dewaxing
- Do not let the moulds dry out before dewaxing. If this happens they should be re-moistened prior to dewaxing
- Use correct burnout procedures
- Do not heat too rapidly
- Do not overheat above 750°C
- Do not allow the flask to cool down and then reheat to final temperature

Inclusions and Foreign Particles

These can lead to brittle castings or may give hard spots which cause problems in subsequent polishing and finishing. Inclusions may be small pieces of investment broken off from the mould, for example sharp corners where the gates are attached, or old investment particles or dirt on recycled metal or they may be oxides or inclusions introduced from the melt, in which case the melting practice needs to be improved, for example, by replacing worn crucibles more frequently.

Bubbles and Nodules On Castings

These are caused by air bubbles on wax patterns that are trapped during filling of the flask with investment plaster. This may be overcome by dipping the wax tree in a wetting agent and allowing it to dry for 20 minutes prior to investment. Insufficient mixing or vacuuming of the investment can also lead to trapped air.

Porosity

There are essentially two types of porosity. These are **shrinkage porosity** and **gas porosity** although it is possible that shrinkage pores may also contain some trapped gas.

Dealing first with **shrinkage porosity**, this is caused by incomplete filling by liquid metal between the dendrite arms during solidification. It is essential to feed the casting during solidification.

Consequently, shrinkage porosity can usually be recognised by the characteristic dendritic shape of the pores.

The important factors affecting shrinkage porosity are:

- The design of the casting
- The sprue and gating system i.e. size and positioning of gates
- The temperature system - the casting temperature and the flask temperature
- The alloy - the solidification temperature range

Do not be afraid to experiment with changing variables such as gate dimensions and the positioning of gates or with the flask and melt temperatures. Do not change more than one process parameter at a time and keep a strict written record of every change you make and its effect on the quality of the castings.

Gas Porosity is caused either by gas trapped during metal pouring or by reactions between the melt and the mould.

Trapped gas may be due to turbulence in filling the mould with the melt or due to the difficulty in permeating the gas in the mould cavity out through the porous investment. There are various methods for improving permeability of moulds. Static vacuum assisted casting is often preferred as it is easier to remove the trapped gas.

Mould reaction gas porosity may be recognised because it often exists at or just below the surface of the casting. Another tell-tale sign of a gas porosity problem is the presence of a raised bubble on the bottom of the casting button.

Research has shown that gas porosity is caused by complex reactions between the Calcium Sulphate (Gypsum) in the investment and Carbon from incomplete wax burnt out, also Oxygen from air and any Hydrogen in the casting atmosphere. The resultant reaction gas is mainly Sulphur Dioxide (SO_2).

Therefore, it is vital that there is no residual Carbon in the flask when casting and this means a maximum temperature of 730°C for sufficient time to ensure complete removal. It is also vital that there are no traces of old investment on recycled scrap when this is remelted for casting as this leads to reaction porosity and the presence of black spots on the surfaces of castings, gates and the central sprue.

Thoroughly clean scrap of investment, preferably in ultrasonic cleaning tanks. Immersing in a cold 30% solution of Ammonium Carbonate $(NH_4)_2CO_3$ is recommended. It is further recommended that the cleaned scrap should be remelted separately and regranulated prior to melting with fresh alloy. Do not use more than 50% recycled scrap in a new melt.

The complete elimination of porosity is difficult but it can certainly be controlled and minimised by careful attention to all stages of the investment casting process.

Density

Definition

Density is defined as the mass per unit volume of a material. We often measure this as grams per cubic centimetre (gm/cm^3). The term 'Density' is numerically the same as Specific Gravity, a term often used for liquids. The Density of a carat Gold alloy can be calculated from its composition and the densities of the constituent metals.

For example, the Density of the following alloy would be calculated as follows:

Composition:

417	Parts GOLD	41.7%
83	Parts SILVER	8.3%
420	Parts COPPER	42.0%
80	Parts ZINC	8.0%
1000	**Parts Total**	**100.0%**

Multiply the proportion of each constituent metal by its corresponding Density or Specific Gravity factor given in the technical tables.

GOLD	0.417 (41.7%)	x	19.32	= 8.06
SILVER	0.083 (8.3%)	x	10.49	= 0.87
COPPER	0.420 (42.0%)	x	8.96	= 3.76
ZINC	0.080 (8.0%)	x	7.13	= 0.57
TOTAL				**13.26**

Sum the results to estimate the Density of the alloy = 13.26 grams per cubic cm.

This means that a perfect cube of this alloy being 1cm in size will weigh 13.26 grams, at 20°C.

Use of This Information:

This information can be used to calculate the weight of any known volume of metal or alloy. Thus, the weight of a flat piece of sheet of a known size and thickness can be calculated with relative accuracy as long as all measures are expressed in centimetres.

For example, taking a piece of metal sheet of the alloy in the example with the following dimensions:

Length x Width x Thickness

15cm x 8cm x 0.7mm

Volume = L x W x T

15 x 8 x 0.07 (0.7mm = 0.07cm) = 8.40cm^3

Weight = Volume x Density

8.4 x 13.26 = 111.38gms

Electroplating

Electroplating

Electroplating is a technique for depositing a thin layer of metal or alloy onto an object, in our case a piece of jewellery, this is achieved by placing the piece of jewellery into a solution (electrolyte) containing the metal to be plated and passing an electric current through the piece and the solution. This causes the metal in the solution to plate out onto the surface of the object.

It is possible to electroplate most pure metals and even some alloys. For jewellery, we are normally interested in plating Pure Gold, carated Gold, Silver and Rhodium for both decorative application and tarnish resistance.

Electroplating is a comparatively quick and easy process to carry out and does not require major investment in costly equipment. It can be done successfully, on a small scale in a jeweller's workshop.

Benefits of Electroplating

- Electroplating carat Gold jewellery with pure 24ct Gold to impart a richer Gold colour
- Electroplating with carat or Pure Gold to give a more uniform colour, hiding variations in colour of the component parts and solder lines
- Electroplating to give a different desired colour; a wide range of colours can be achieved by co-depositing Gold with other metals
- Electroplating to hide surface defects or to improve properties
- Electroplating base metal or Silver items with Gold to obtain a Gold appearance as in fashion jewellery and gilt Silver

Rhodium is often used to give a good white colour to white Gold jewellery (which is often not a good white colour) or is used selectively on yellow Gold jewellery to give local areas a whiteness, often around gem stone settings.

Basic Principles of Electroplating

Electroplating is carried out in an electrolytic cell (or bath). This comprises two electrodes that are electrically connected and immersed in a solution called the electrolyte, which contains the metal to be plated.

When an electric current is passed through the cell, metal dissolved in the electrolyte is deposited on the negative electrode - the cathode - whilst metal from the positive electrode - the anode - may be removed and dissolved in the electrolyte. Thus metal passes from the anode into solution in the electrolyte and is then deposited on the cathode.

Thus, if the piece of jewellery is the cathode and the electrolyte contains Gold, then Gold can be deposited on the jewellery item. Often in electroplating, an inert anode, for example Titanium, will be used. Control of the concentration of the depositing metal in the electrolyte solution is made by direct additions of the appropriate metal salt (chemical) to the electrolyte. In very sophisticated electroplating equipment, this can be monitored by computer control and additional salts added automatically to the bath to maintain optimum plating conditions.

The amount of metal that is deposited is governed by Faraday's Law, which states that: "The weight of metal deposited is proportional to the quantity of electricity passed". This is defined as the current (amps) multiplied by the time (hours). The weight deposited for a given quantity of electricity will vary with metal being deposited and is related to its atomic number and valency through a factor called the electrochemical equivalent.

Faraday's Law is useful in calculating and controlling the amount (weight or thickness) of metal deposited on a piece of jewellery. At a constant plating current and metal concentration in the electrolyte, the thickness will be directly proportional to the time of plating. Double the plating time and you double the thickness.

Factors Affecting the Process

For decorative applications, a uniform thickness of electroplate is required over a complex shaped item. This can be a problem at sharp edges and recessed surfaces, for example. A bright deposit, with good adhesion to the underlying metal substrate is also desirable, but a highly stressed deposit with a tendency to crack and spall is to be avoided as is one that is cracked or micro porous as this could lead to tarnishing or corrosion during subsequent wear.

If we are co-depositing more than one metal, i.e. a carat Gold, we also want good control of composition - a uniform Gold content over all the surface and throughout the thickness, for example.

To achieve consistent results it is essential to maintain the following controls:

- Control of electrolyte formulation and pH (a measure of acidity or alkalinity)
- Control of anode surface area and position
- Control of electrical conditions
- Control of temperature

Electrolyte

The electrolyte contains the metal (or metals) to be deposited in solution in a sufficient concentration. In Gold plating solutions, this will often be in the form of Gold Potassium Cyanide salt. Properly formulated electrolytes will also contain other additions to give good plating properties, for example to control:

- The throwing power of the bath which means good uniformity of thickness over the piece being plated
- The brightness of the deposit. Special brighteners are added to assist
- The internal stress in the deposit. These additives control the build-up of stress to prevent cracking and spalling
- The chemical stability of the electrolyte and may include buffering agents to control pH which is a measure of the acidity or alkalinity of the electrolyte

These additives are usually proprietary to the electrolyte manufacturers. During plating, it is usual to agitate or stir the electrolyte to maintain optimum plating conditions.

Contamination

It should be noted that cleanliness of the electrolyte is vital; any contamination can lead to poor plating performance. So carry over of cleaning liquids, other electrolyte solutions and rinse waters into the bath must be avoided and the bath kept covered to prevent dust and dirt from dropping into it.

Anode Area

Anode area and position are important to efficient plating and uniformity of deposit. There is a tendency for plating to be thinner in areas out of line of sight of the anode and thicker in areas closest to the anode. Correct positioning and a large surface area are important for good plating.

Electrical Conditions

The correct electrical conditions are critical for good plating results. In particular, current density (the current divided by surface area of the piece being plated) plays an important role, especially in alloy plating, where deposit composition is controlled by current density. If the current is too high, the plating speed increases but one may get a porous, dendritic deposit instead of a bright one and it may be accompanied by gas evolution which affects the surface finish. If it is too low, then the deposit may not have a good appearance and plating will be slow.

Temperature

Temperature will also play a role in plating quality. Follow the electrolyte supplier's recommendations.

Surface Preparation

For good quality plating and good adhesion, the condition of the surface to be plated is critical. Most plating defects arise from unclean surfaces prior to plating.

The surface to be plated MUST be clean and free from grease, dirt, oxides and tarnish films or polishing compounds. Greasy, dirty surfaces will not be wetted by the electrolyte and may not be plated! It helps to have a bright smooth surface, free from defects and imperfections, if one wants a bright polished finish. Defects to be avoided include casting porosity, inclusions, embedded polishing compounds, scratches and tool marks and pitting from over-pickling.

The surface to be plated can be prepared by normal polishing techniques and then cleaned in several ways:

- Ultrasonic cleaning in detergent solution
- Degreasing in solvents, preferably in an ultrasonic cleaning bath
- Acid cleaning with pickling acids
- Steam cleaning under a high pressure jet of steam
- Electrolytic cleaning; this can also chemically activate the surface for plating
- Chemical cleaning with reagents, often at high temperatures

In practice, one, or possibly two, techniques are used. For example, degreasing and acid pickling, followed by rinsing in water and drying. Many proprietary cleaners are alkaline with wetting agents and surfactants added. Deionised or distilled water should be used as the final rinse to prevent any deposits from the water being left on the surface.

For good plating and adhesion, it is often necessary to pre-plate the surface with a strike coat or an under layer, such as Nickel or Palladium. Follow the electroplating salt manufacturer's recommendations.

Safety and Pollution

Many electrolytes used in the jewellery industry are based on Cyanide. This is particularly true for Gold. Cyanide is very poisonous and MUST be handled with great care.

A Golden Rule is NEVER to allow drinking and eating in an electroplating facility and to have strict control and procedures in the plating shop or area. Protective overalls and visors should be worn and changed regularly. Cleanliness is vital.

For safety, Cyanide electrolytes and plating salts MUST be kept in locked cupboards. Keep Cyanides and acids apart from each other. Acid will react with Cyanide to liberate deadly Hydrogen Cyanide gas!

Old electrolytes, as well as cleaners and rinse waters must be disposed of safely and NOT thrown away down the sink or drain. Note that there are strict regulations governing disposal of such solutions.

Acid-based, non-Cyanide electrolytes must also be handled with great care.

All reputable salt or electrolyte manufacturers will provide Materials Safety Data Sheets on their products and give good advice on health and safety procedures.

Gold Plating

There are many electroplating systems on the market for putting Pure Gold and Gold alloy deposits onto the surface of jewellery and base metals for decorative applications. There are also many others for technical applications such as electrical connectors, where the coating properties must give a certain technical performance.

The commercial electrolytes may be classified into Cyanide and non-Cyanide based and may contain minor alloying additions to control colour and other properties.

All Cyanide electrolytes are based on the use of Gold Potassium Cyanide, which contains about

68% Gold. However, most electrolytes do not contain anything like this concentration of Gold. Some electrolytes are acid; others neutral and others are alkaline.

Practice

If electroplating onto base metals, it is common practice to first electroplate a thin flash or 'strike' coat of Copper to provide a good key, then an undercoat of Nickel, Bronze or Tin. The purpose is to provide levelling and brightening to the substrate and to inhibit migration of the underlying Copper into the Gold layer, causing it to turn redder.

With the European Directive against the use of Nickel, there is a trend to use bronze (Copper-Zinc-Tin) or Tin or Palladium as the underlayer. Often a 'strike' Gold layer is then deposited of about 0.1 microns thickness before the full Gold layer is deposited from a different electrolyte. These are known as duplex systems.

For jewellery applications, a deposit thickness of about 0.5 – 5.0 microns is typical, but very thin 'flash' coatings may be used where cost is more important than quality.

In selecting an electrolyte and plating system, it is good practice to seek the advice of your plating materials supplier.

Plating removes Gold from the electrolyte; thus, it is important to maintain the correct concentration of salt in the bath by periodic additions of salt. This requires an ability to measure the Gold concentration in the bath.

Between each stage of surface preparation and electroplating, it is important to rinse the items being plated before moving to the next step of the process. This prevents bath contamination and loss of precious metal salt. This is known as 'Drag-out'. Of course, after completion of the total process, the item should be rinsed and dried. Do not use tap water as this will leave deposits on the surface after drying.

Masking

Sometimes, it is desirable to mask off areas where plating is not required. This can be done by painting on an organic lacquer, such as nail polish to those areas where plating is not wanted and allowing to dry. After plating, the lacquer can be easily removed with an organic solvent such as Acetone. There are many products on the market. Remember, such lacquers are inflammable and must be stored in well closed containers.

Rhodium Plating

Rhodium is a Platinum group metal with a good white colour and is hard and tarnish resistant. For jewellery a bright, defect free and hard deposit is desirable. There are several systems available; all are sulphate based and very acidic. They tend to be prone to contamination and hence poor plating performance.

Usually, deposit thickness is about 0.5 microns, but up to 2 - 3 microns, is plated onto Gold jewellery to give the required characteristics. There is a tendency for stress build-up as thickness increases, these stresses will eventually lead to cracking of the Rhodium plating. Commercial baths contain special additives to control stress build-up.

For high carat Golds, a thicker layer of Rhodium is plated directly onto the substrate, but for low carat Golds, a Nickel (or Palladium) interlayer is plated first, allowing a thinner Rhodium deposit without loss of colour and providing good corrosion resistance.

As with Gold, good surface preparation is essential. The following practice is recommended:

- Electrolytic cleaning
- Rinse in demineralised water
- Check surface wettability (no formation of droplets)
- Dip piece in aqueous solution of sodium Cyanide (35gm/l)
- Rinse in running water or demineralised water

- Dip in electrolyte with power on (do not touch) and electroplate
- Rinse and dry

Plating should take from 30 seconds to two minutes, depending on thickness desired. Inert anodes of Platinum or Platinum plated Titanium are used at 4cm - 5cm distance with a surface area at least as big as the cathode. The bath should be well agitated or stirred.

Periodic replenishment of the Rhodium in the bath is necessary and this is done with special replenishment solutions which have high Rhodium concentrations but low acidity. It is important to avoid contamination of the bath with other metals, so good rinsing and use of non-metallic tanks is recommended.

Equipment

Basically, electroplating is a simple process and can be performed in glass beakers with a simple D.C. electrical supply. However, if good consistent quality is desired, it is preferable to use purpose-made equipment, which will include:

- Plating tank - preferably in glass or plastic, with lid. For example, Pyrex Glass, Teflon, Polypropylene, PVC and HDPE are all acceptable
- Additional rinsing tanks, with lids
- A reliable D.C. power supply with sufficient current output
- Electrolyte temperature heating and control system
- Stirrer, pump and filtration systems
- Insoluble anodes (often Platinum or Platinum plated Titanium sheet or gauze)
- Inert connecting wires for electrodes where immersed in bath
- Ability to plate several items simultaneously
- Fume cupboard or fume extraction

Whether one is plating on a small scale on a bench or on a larger mass production scale, there are many suppliers of purpose-made equipment for electroplating on the market to suit all needs. It is also possible to find a local fabricator to make one tailored to your needs.

Basic Alloying & Fabrication

Simple Alloying Procedure

Carat Gold alloys may be made by melting together the constituent pure metals and Fine Gold or by melting together the correct master alloy and Fine Gold.

1. Weigh up Alloy Components

The elements of an alloy are weighed individually on scales that are accurate to 100th of a gram.

2. Melt Highest Melting Point Elements

The elements with the highest melting points are placed together in a crucible and melted under the cover of a reducing flame. For yellow and red Golds, this will normally be Fine Gold.

3. Add Low Melting Point Elements

Add the other metals slowly; this will normally be Copper and then Silver. Care must be taken when adding Zinc as it has a low melting point and will readily evaporate off. Zinc should, therefore, be added at the last minute, preferably as a Copper-Zinc master alloy (70/30 brass; note: free machining brasses usually contain Lead and must NOT be used) or as Zinc metal wrapped in Gold or Silver foil and pushed under the surface. Some Zinc will be lost and must be compensated for.

4. Cast the Molten Alloy

Once the low temperature elements have been added to the molten alloy, it can be cast into a mould. This will typically be an Iron mould, lightly oiled or coated with carbon from a torch with a ‘smoky’ reducing flame. **Safety note:** Ensure the mould is dry; a damp mould can be dangerous, causing molten metal to be forcefully ejected in an explosive manner.

Care must be taken not to overheat the alloy and burn out the lower melting point metals. To ensure a homogeneous alloy, ensure the mix is well stirred before pouring. Use a carbon rod to ensure the alloy does not become contaminated.

5. Quench the Ingot

When solidified, the newly cast ingot is then quenched in clean demineralised water. Please refer to Quenching Techniques in the “Annealing” section of this document.

6. Clean the Ingot

The ingot is then cleaned to remove all surface oxides; this can be done using a wire brush or abrasive wheel.

Simple Fabrication Procedure

The ingot is passed through a rolling mill, either square section for wire or flat section for sheet.

If wire is being manufactured it is then pulled down through a series of dies that decrease in size with each pass. The alloy is periodically annealed - a process of restoring ductility to the metal. The metal will progressively work harden by the cold working processes, the annealing process softens the alloy in order to make it further workable. If overworked and not annealed, the product will crack and split, sometimes to the point of destruction. Many solders are particularly prone to this. When sheet is at its finished thickness, it is polished and cut to size. When wire is at its finished diameter, it is coiled and cleaned.

Note that the surface finish of the sheet will reflect the original ingot surface and the surface polish of the rolls. It is important to have clean, inclusion-free ingots of good surface and rolls with a good bright polish and without imperfections, such as scores and marks. Wire drawing dies also need to be free from blemishes because any blemishes in the dies will show up as elongated marks and scratches on the finished wire and will be difficult if not impossible to remove.

Platinum Information

For jewellers not used to working with Platinum, it can appear to be quite difficult. This is because Platinum's properties are quite different to those of Gold and Silver. However, once its characteristics have been mastered, working with Platinum is not so difficult.

Platinum Alloys

As with Pure Gold and Silver, Pure Platinum is very soft and so is not generally suitable for hardwearing jewellery. However, there are a range of Platinum alloys at 960, 950 and 900 purity that are suitable for jewellery making. Each has different characteristics and so different uses in jewellery manufacturing. Some are good for investment casting; others are better for fabricating and others are good general purpose alloys.

The table below shows the most common alloys and their suitability for various manufacturing processes.

It is important to note that Platinum and its alloys have much higher melting temperatures than Gold and Silver and this brings differences in melting and soldering operations. Pure Platinum melts at 1760°C.

As much higher temperatures are involved, eye protection is an important safety aspect to note.

Safety: Eye Protection

Melting, soldering and welding operations on Platinum involve temperatures in excess of 1500°C at the joint face, and between 2000°C and 2800°C in the heat source. The white radiation emitted at these temperatures is very intense and is hazardous to the unprotected eye. Even a short exposure is certain to leave an after-image on the retina that will persist for several minutes and distort both positioning and colour judgement. Longer exposures will produce "arc-eye" or even permanent damage to the retina.

Choosing a correct filter system to protect the eyes requires a reasonable compromise between filtering out all possible dangerous radiation and leaving enough intensity and colour to enable the operator to judge position, temperature and the condition of the piece of jewellery being heated or alloy being melted. Platinum is melted at temperatures higher than Steel. Shade 5/GW (Shade 5, gas welding) filters can be used for short work periods when soldering Platinum alloys, but choose at least Shade 6/GW when using the highest temperature Platinum solders for longer periods. Shade 9/EW (Shade 9, electric welding) to 11/EW filter glasses, should be used for long welding exposures.

Warning: Never try using even the densest sunglasses. At the ultraviolet end of the spectrum, they may offer some protection against general sunlight, but not against a sharp concentrated image of an arc or oxy-gas flame.

Maybe less dangerous, the infra-red component of high-temperature flames also needs to be guarded against. While an occasional short exposure to the skin may not be harmful in itself (personal discomfort usually quickly reminds the occasional operator that welding and soldering heat sources

Platinum Alloy	Hardness Vickers HV	Casting	Fabrication	Die Striking	Machining
5% Copper	120	Good	Good	Good	Good
10% Iridium	110	Satisfactory	Excellent	Excellent	Poor
5% Iridium	80	Poor	Excellent	Excellent	Poor
5% Cobalt	135	Excellent	Good	Good	Good
5% Ruthenium	130	Good	Excellent	Good	Excellent
5% Palladium	70	Good	Poor	Good	Very poor
5% Tungsten	140	N/A	Excellent	Poor	Excellent

radiate heat very directly), repeated or prolonged exposure is dangerous. The skin should be covered, or the head and shoulder area screened, not just the eyes.

How to Work Platinum

Working with Platinum is similar in many ways to working with other precious metals, white Golds especially. Once they become accustomed to its unique properties, skilled jewellers should not have difficulty working with Platinum. It is worth noting that Platinum tends to gall (stick) to tools and so tool and die wear can be a problem; diamond machining requires different tool angles and machining speeds.

Cleanliness and Contamination

It is very important to maintain high levels of cleanliness on the bench and avoid cross-contamination. Platinum is readily contaminated by other metals when heated. It is important, therefore, to use clean tools that will not leave residue or particles of other metals on the Platinum. Due to extreme differences in melting points, other metals tend to dissolve into the surface of Platinum as it is heated for annealing or soldering, causing both pits and discolouration of the surface. Once another metal is alloyed into the Platinum, it is impossible to remove except by refining. Separate files, abrasives, polishing compounds and buffs should be used to prevent surface contamination. Particles of Gold etc. can be forced into the surface of the Platinum by contaminated tools.

Most jewellers use a separate set of tools for working with Platinum. Cross-contamination can Lead to embrittlement of Platinum and its alloys. Avoid the presence of Lead in particular.

A less drastic form of contamination occurs from the use of tweezers, clamps, pins, and binding wire as holding or fastening devices for soldering. If Steel, Iron, Chrome or Nickel-plated elements are within the high heat area required to flow Platinum solder, they produce a blackish stain on the metal. Surface contamination with ferrous metals can usually be removed with Hydrochloric Acid. If however they come into contact with the joint, it is probable that total contamination through fusion will result, a situation from which there is no salvation. Staining is less likely to occur away from the actual heat zone, a distance of at least 1.5cm away from the tip of the flame is considered safe.

Cold Working

Some Platinum alloys will work harden rapidly and may require some force to deform them, although cracking is not usually a problem. Others like Platinum – Palladium alloys work harden more slowly. All Platinum alloys can generally be deformed or reduced by 70% between anneals. Selection of reduction/annealing schedules should be done on an alloy by alloy basis to ensure good grain size control. Light reductions of 30% or less between anneals should be avoided as a large grain size will result, leading to the corresponding orange peel effect on further deformation.

In drawing wire, the best drawplate for the final draw is a drawplate with diamond nibs. This will give a polished surface. Since most Platinum alloys do not discolour the polished surface will remain after soldering.

After annealing Platinum, there is usually no need for further treatment. Platinum does not have to be pickled, as there is no oxidation or discolouration from heating. All fabrication should include as much pre-polishing as possible, since heating for soldering has little or no effect on final finish.

Annealing Platinum

Almost all the Platinum alloys resist oxidation during annealing. Annealing can be done using a conventional hand-held torch made for use with Oxygen and either natural gas, LPG, or artificial gas, although furnace annealing allows better control. Eye protection (see page 136) is essential. The flame should be a bright blue oxidising flame in order to achieve the temperatures required. Note: reducing flames are to be avoided.

Most cold-worked alloys begin to stress relieve at 600°C (dull red) and then soften rapidly at 1000°C (bright orange). Thus, this temperature may be regarded as the annealing temperature.

The piece to be annealed must be clean, if there is any doubt; it is advisable to pickle before bringing to temperature. It should be supported on a clean brick used exclusively for this purpose (not charcoal). Platinum embrittles quickly when contamination occurs, the need for cleanliness cannot be overemphasised. Even minute quantities of Lead, Aluminium and Steel are to be avoided as they will make further work difficult or impossible.

Experience and personal observation will teach one the precise time when annealing is required. Excessive annealing can cause grain growth which may affect subsequent forming or polishing operations.

Where thin or highly-stressed sections are involved, it is better to stress relieve for a short time before taking to the higher temperature for annealing. The time that the piece should be held at the "bright orange" temperature will depend on its size and thickness. As a rough guide, a piece 2.5cm square by 1mm thick will require about 1 minute. The time will be proportionately more or less for other sized pieces. For example, an average ring would require approximately 30 seconds.

Furnace annealing is preferred for large pieces to ensure even heat distribution, which may be difficult to achieve using a torch. Do not use a Hydrogen-containing atmosphere in the oven because of the danger of Hydrogen embrittlement.

Platinum alloys can be cooled in air or quenched in clean water immediately after annealing. Do not use standard tongs or tweezers to handle the red hot piece; let it cool to normal colour or use Tungsten Carbide tweezers.

Important: Annealing Platinum Cobalt Alloys

Platinum Cobalt casting alloys are slightly magnetic and so it is important to avoid contamination of the piece with magnetised bench scrap when annealing or soldering. The melting temperature of this alloy is 1765°C.

Melting and Casting

Platinum alloys have high melting temperatures and are melted by an oxy-fuel flame or medium frequency induction heating. In torch melting, only Oxygen with a gas fuel is capable of giving sufficient heating for melting (and welding). No fluxes are necessary when melting Platinum.

Platinum should be melted in refractory ceramic crucibles such as fused Silica, Alumina or Zirconia. To avoid thermal shock, the crucible should be heated slowly for the first melt. Pre-heating in a burnout furnace is useful provided there is no contact with any residual wax. Graphite crucibles must be avoided because Carbon can embrittle Platinum. If stirring of the melt is required, use only rods made from fused Silica, other ceramic material or Tungsten Carbide.

Investment (lost wax) casting of Platinum is not difficult but requires use of special investment powders, (phosphate bonded instead of gypsum bonded). Phosphate bonded investments are more dimensionally stable and no allowance for contraction is necessary.

Platinum offers a high degree of fluidity to fill small sections and detail. Centrifugal casting is the preferred method to ensure good mould filling. Casting can be done in a small vertical casting machine with torch melting or in a larger horizontal casting machine with either torch or, preferably, induction melting.

Heat loss when pouring Platinum is an area of major difference when compared to casting Gold. Casting scrap may be safely recycled and even 100% clean scrap charges can be used.

Platinum can be cast on a small scale, say 35 grams to 70 grams or more typically in the 100 grams to 450 grams range. Because of the high density of Platinum casting alloys, such weights would equate with 10 to 20 settings or approximately 4 to 24 ring shanks.

Waxes may be mounted in tree fashion, as for Gold, for the higher weights up to 1kg but at the smaller scale, direct attachment of the short feed sprues to a flat cone or to branches off the base are commonly used.

As the flask cannot be heated much over 1000°C, there is a large (750°C) temperature gap between the melt and flask, giving a high chill factor and so solidification is very rapid compared to Gold. A superheat of about 200°C - 400°C, depending on section size, is used to avoid premature freezing. Safety: Eye protection is necessary when melting and casting (see page 136).

When the metal has been cast, it should be allowed to solidify and then the flask, held in tongs, quenched into cold water. Removal of the tenacious investment from the casting can be achieved by steam cleaning, grit blasting and by dissolution in Hydrofluoric Acid. Take great care with this very dangerous acid.

To ensure alloy homogeneity in the final melt the use of casting grain or chopped sheet and wire of defined fineness is the preferred charge material. Scrap is preferentially pre-grained before use.

Welding

Safety: Protect eyes with welding glasses or goggles during welding. (See "Eye Protection" on page 136).

Platinum and its alloys can be welded by torch, TIG welding or laser, no fluxes are needed. If a filler is required then the same alloy can be used so no colour changes will occur, a distinct advantage when sizing rings. Even so, it is good practice to minimise the amount of filler used by making the joints fit tightly. If the joint is made tightly, the only filler material needed is a piece approximately 0.1mm to 0.5mm thick of the same alloy.

When welding or soldering by torch, the torch tips recommended are 0.75mm to 1.00mm diameter.

For all small flames, an Oxygen regulator with a low-end capacity should be used to maintain a steady 1PSI to 2PSI or 0.5kPa to 1.0kPa of pressure.

The best fuel for soldering and welding is Oxygen with a gaseous fuel such as natural gas or propane, check torch specifications for which gases are suitable. Acetylene should not be used as it readily contaminates Platinum leading to brittleness and cracking. Remember to wear suitable eye protection such as welding goggles!

Welding Practice

The two components to be joined are clamped on either side of the vertical filler and the whole joint is heated slowly, beginning with the heavier sections on either side and gradually moving the torch flame to concentrate on the fringe of filler material. The filler should melt down into the joint before the two components fuse any more than superficially at the interface. Remove the flame as soon as fusion has taken place. If the joint is long, like a seam, the filler will be a long strip with its long edge pointing along the seam, but still horizontal. Concentrate on one end, and as fusion begins, move slowly along the joint. If the seam is extensive, it is possible to use a thin wire pointing into the flame.

Due to Platinum having a relatively low thermal conductivity, the heat tends to stay concentrated near the point of application, unlike Gold and Silver, where the heat is conducted away. This low thermal conductivity helps control the size of the joint and simplifies making multiple joints on the same piece of jewellery.

The joint should finish with the smallest "bulge" of matching colour, which can now be smoothed down to match the original cross section. This technique is well suited to joining relatively heavy and matched sections such as ring shanks as well as settings, shoulders, bangle sections, pendants and brooch parts.

Platinum can also be welded by laser in much the same way as other metals. The precise positioning of the laser beam means that the high energy can be focused on the seam. The low thermal diffusivity is advantageous here too. In-situ laser welding of links in chain-making is common practice. Repair of Platinum jewellery is also possible with laser welding, with the focused beam enabling repairs to be made close to gemstones. If necessary the gemstones can be kept cool by covering with a wet tissue or cotton wool.

Soldering

Safety: Protect eyes with welding glasses or goggles during soldering. (See "Eye Protection" on page 136).

Platinum components may be readily soldered with a wide range of solders, some of which can be done with a gas-air torch. To ensure a good colour match, it is advisable to use solders containing Platinum; this may require use of an Oxygen-fuel torch flame to attain the required temperature. (See "Welding" on page 139).

Sound soldering is dependent on standard soldering practice. Jigging is not difficult; use low thermal capacity jig materials and keep the jigs well clear of the flame so no contamination of the Platinum can occur. Use many small pieces of solder along the joint seam rather than a few larger pieces. In this way the solder will only flow where it is required and heating should be stopped the moment flow occurs.

The aspects discussed earlier about contamination apply here in soldering as well. Use no carbonaceous materials, borates or Silica under reducing conditions. Note that attempts to solder up or repair cracks due to contamination will invariably exacerbate the problem.

Solder Alloys

As with Gold solders, there are several grades with melting temperatures about 100°C apart. Extra easy starts at about 950°C to extra hard at about 1500°C. The latter tends to contain higher percentages of Platinum. Solder grades are often designated by their melting temperature e.g. 1300 grade solder has a melting temperature of 1300°C However when designated 950 Platinum the solder must contain a total of 950 parts per 1000 of precious metals.

Most Platinum solders are mixtures of precious metals but not all contain Platinum. Colour and temperature control is achieved by varying the proportions of Platinum, Palladium, Gold and Silver.

In addition, Platinum can be soldered with lower temperature Silver and white Gold solders although this is not recommended except when joining Platinum to other metals, which cannot tolerate the high heat of Platinum solders.

Flux is not necessary for any solders over 1300 grade since Platinum does not oxidise. However a liquid flux is helpful in placing and holding solder chips in position during soldering. It is important to use the flux sparingly and to dry it carefully to prevent displacement of the solder.

Platinum is difficult to solder without a perfectly fitted joint. The two pieces to be joined must be in contact with one another for the solder to flow properly. Platinum solder does not fill gaps by flowing from one piece to another. If the solder flows onto one piece, there should be no attempt to reheat without applying a new piece of solder. Time and care should be taken to ensure a close fit prior to soldering.

Solder is generally supplied in sheet form.
It should be rolled down to the thinnest gauge possible (0.1mm or less) and then cut with small shears into very thin strips. Platinum solder is best used on very small areas at a time and by moving the torch down the length of the seam at 2mm to 3mm at a time. A delicately pointed

pair of soldering tweezers is helpful for placing solder (AA stainless are recommended).

As with welding, small torch tips are recommended. It is not necessary to heat the area to be soldered slowly (except to dry the flux). Instead, the flame is placed directly on the joint, or on one section of a long seam, and held steady until the solder flows.

Heating too much of the seam at one time can cause warping. Quick and direct heat with a small flame keeps distortion to a minimum. If the flame is positioned correctly and the joint is well fitted, soldering will occur very rapidly. It can be seen as a shiny flow. After the solder flows, remove the flame immediately to avoid pitting and frosting of the soldered joint.

Care must be taken with lower temperature solders as they will deteriorate with reheating whilst higher temperature solders can be reheated with proper temperature control. Since most Platinum alloys do not oxidise when heated all parts can be completely finished and polished before being assembled and soldered. This is a decided advantage in complex assemblies. Provided of course that the correct amount of solder is used and therefore there is no cleanup on the joints and seams.

The positioning of pieces for soldering can be a difficult problem because the possibility of contamination from tweezers or Iron binding wire. Any Steel holding devices must be placed sufficiently far away from the heat area to avoid contamination. Third Hands with Tungsten Carbide tips are recommended as are Tungsten Carbide pokers. Steel pokers cannot be used.

If multiple solders are used they should be applied in diminishing order, hard, medium and easy. However, it is possible to make multiple joints, even in close proximity, with only one grade of solder because of the low thermal conductivity of Platinum.

When joining Platinum to Gold, it is important to use a Cadmium-free Gold solder as Cadmium will migrate into the grain boundaries of the Platinum and cause brittleness. Solders with Cadmium will also tarnish (oxidise) during soldering. Do not coat the piece with Boric Acid prior to soldering, as this will lead to brittleness and breaking along the joint. If any tarnishing has occurred after soldering, coat the effected area with Boric Acid, heat to approximately 1200°C (red-orange colour) and pickle to remove the oxides.

Finishing

There are no easy short cuts to polishing of Platinum, its unique characteristics can make the process laborious. There is a greater chance of clogging files and wearing out of abrasive and polishing media. Once polished, it stays free from tarnish virtually forever. In use, Platinum will scratch with heavy everyday wear. For that reason, some prefer a matte finish, which tends to burnish. Sometimes a thin electroplate of Rhodium is applied to give a good hard surface. Alternatively, a combination of finishes may be employed, ranging from a 'silky' polish to patterned or random texturing, however, a fine high polish is readily achieved by following regular polishing procedures and finishing techniques. Whenever possible, it is best to pre finish components prior to assembly as solders are more easily polished than Platinum and may be over-finished or dragged out of the seam.

Polishing is often done manually, but barrel and vibratory polishing machines can be used successfully.

Matte finishes can be achieved by use of a fine abrasive or by grit blasting, wire wool or Steel or Brass rotary brushes. Rotary abrasive flap brushes are very versatile. Highlight lines and mirror streaks can be produced with highly polished Tungsten Carbide mini-tools.

Practice

It is essential to maintain a separate set of files, buffs, brushes and compounds reserved exclusively for Platinum to avoid contamination and achieve the ultimate Platinum finish.

It is important that all scratches are removed at the work bench. Always begin with the least aggressive abrasive that will accomplish the task and remove all defects before moving to the next step. Use closely spaced abrasives as skipping a step to save time will ultimately require more time and result in a less attractive finish.

Once the scratches are removed, it is important to burnish the surface of the Platinum. This is done with a polished Tungsten burnisher by hand, or with tumbling devices. If it is done by hand, the tool of choice is a Tungsten burnisher, which rubs a highly polished rod of Tungsten over the surface of the Platinum. Before you start, be sure the burnisher's surface is highly polished; if it's at all scratched, you will transfer those scratches to the ring. Using a light oil for burnishing will prevent the burnisher from skipping and marring the Platinum.

For the polishing sequence there are usually four levels of polish:

1. Using an 800 grit polishing compound, the jewellery is prepared
2. After that, a 1500 grit compound is used
3. This will be followed by another step using 4000 grit
4. The final high gloss and luster is achieved with an 8000 fine compound

With Platinum there are no shortcuts. If there are still scratches in the piece, the polishing sequence will not remove them, and one must go back to an abrasive to remove them. Polishing compounds designed for Gold and Silver have little effect on Platinum, and it is always a good choice to use compounds especially developed for Platinum polishing. When buffing with an abrasive compound, you'll need to generate enough heat to get the metal almost flowing. To accomplish this, you'll want to select a larger diameter buff. For example, a 10cm buff will have a surface speed of about 110,000cm per minute, while the speed of a 15cm buff is about 165,000cm per minute. The greater the speed, the greater the heat. You must also pay attention to the buff's physical characteristics: hard felt flat laps work best for corners and edges, while horsehair brushes produce a nice shine on filigree and other details.

When buffing, apply the same method as for filing: buff in a diagonal direction, then switch to the opposite diagonal direction when polishing over a solder seam. Polish across it rather than along it; this will prevent you from pulling out the solder. During this process, do not let loose metal and compound build up on the ring; this will cause the buff to glaze and consequently scrape the surface of the ring.

Repeat this operation with the next finer polishing compound, using an untreated stitched muslin buff; this should give a highly reflective surface and a lustrous finish. You may now apply additional finishing techniques such as Florentining, Stippling or Sandblasting to compliment the polished areas. Since Platinum does not oxidise or tarnish, these extra finishes will not harm the ring, instead they present a varied texture to contrast with the meticulously polished areas.

This is all part of the Platinum experience and of learning how to "think" Platinum. As Platinum does not oxidise, it is good practice to polish individual components before assembly. This is especially important, if there are other precious metals included in the assembly. The Platinum must be pre-polished before the other components are being attached, as it is possible to over-polish the Gold portion in trying to polish the Platinum. Platinum is not difficult, it is just different.

Reusing & Adjusting Scrap Gold

Fabrication Alloys Versus Casting Alloys

Gold alloys designed for use in the wrought processes generally lend themselves to re-use. Treated correctly, avoiding oxidation and contamination, they may be remelted and reworked. However some casting alloys are not suited for re-use in wrought applications, although they may be used as part of the charge for new castings providing of course they have been adequately cleaned and are oxide free. The added constituents to some casting alloys that impart the deoxidising and grain refining properties can render the alloy more brittle and with less forgiving grain structures. When cold worked, these alloys may crack.

Reworking

Reworking should only be done where the Gold content or the carat rating of the alloy is known and contamination by a lower carat alloy is not possible. The jeweller has a legal responsibility to carat stamp the alloy and hence must be sure not to under-carat the alloy. Contamination by a higher carated alloy results in the jeweller giving away Gold at cheaper rates and is not a cost effective practice. White Gold should be kept separate from yellow and pink/red alloys. Some white Gold alloys tend to undergo greater oxidation when being remelted which can result in a brittle and unusable metal. The 18GP white Gold alloy (and others) has been specifically designed to help overcome the oxidation problems when heating or remelting.

Contamination

In particular solders, Lead and Iron may find their way into the scrap mix because of their common use in the jewellery industry. These metals, if melted with the scrap, will render the resulting alloy unworkable and hence refining would be the only option from this point. Very low percentages of these metals can render the final alloy too brittle to work.

Treating Scrap

- Melt down on its own, into an ingot or a bar; cleanliness of the material is vital
- Add as part of a crucible charge when making up an alloy with pure metals
- Return to a refiner for credit

The crucible charge may be entirely made up of scrap Gold when the composition of the scrap is accurately known, it is quite clean, it is all of the same carat and there is positive tolerance* in the Gold content. In most cases, however, it is advised that the quantity of scrap employed in alloy making is approximately 50% of the charge with the rest being new metal.

*Positive tolerance may be achieved through the remelting of an alloy due to base metals being oxidised and fluxed out of the molten pool, leaving a relatively higher percentage of Gold in the final make up.

Adjusting Scrap

The more accurately the composition of scrap is known, the safer and more economical it is to remelt and reuse. Almost invariably, it pays to assay the scrap before remelting. As a general rule, it is easier, safer and cheaper to lower the carat of scrap than to raise it, but there is no point in doing this if the carat so obtained is not economical or practical for reuse by the jeweller.

To ensure adjusted alloys are not under carat it is recommended that a positive tolerance of .002 is applied to the following formulae. This will raise 9ct to .377 and 18ct to .752.

Formula for Lowering the Carat Rating

The simplest way to lower the carat rating of a known Gold to a chosen lesser carat is to add only master alloy, no Fine Gold or any other carat alloy.

On this basis the formula for calculating the **weight of master alloy** to be added is:

$$\frac{\text{Scrap weight x (Scrap carat - Desired carat)}}{\text{Desired carat}}$$

This formula will work when the weight of the master alloy addition and of the scrap is either in grams, ounces troy, or kilograms, however the units must not to be mixed. Similarly, parts per thousand or percentage Gold may be substituted for carats.

For example, supposing some off cuts and old 18ct jewellery are added together with a total weight of 500gms. The batch is assayed and is 71% (710 fine) and it has been decided that it will be adjusted down to produce 9ct stock:

$$\frac{500 \times (710 - 375)}{375} = \text{446.66gms of master alloy to be added}$$

The formula can be cross checked by totalling the weight of the original scrap and the weight of the master alloy addition then multiplying the weight of the original scrap by the assayed Gold percentage to determine the Fine Gold content in grams.

Multiplying the total weight of the batch by the desired or targeted Gold content.

Finally comparing the Fine Gold content from the above two calculations:

500 + 446.66 = 946.66gms

500 x 71.0% = 355gms Fine Gold

946.66 x .375 = 355gms Fine Gold

Formula for Raising the Carat Rating

The most straight forward and fool proof method is to add only Fine Gold to the alloy to be upgraded. On this basis the formula for calculating the **weight of the Fine Gold** to be added is:

$$\frac{\text{Scrap weight x (Desired carat - Scrap carat)}}{\text{(24ct - Desired carat)}}$$

This formula will work when the weight of the Fine Gold addition and of the scrap is either in grams, ounces troy, or kilograms, however the units must not to be mixed. Similarly, parts per thousand or percentage Gold may be substituted for carats.

For example say a 500gm batch of offcuts and old 18ct jewellery now assays at 71% (710 fine) and it has been decided to restore it to 18 carat:

$$\frac{500 \times (750 - 710)}{(1000 - 750)} = \text{80.00gms of Fine Gold to be added}$$

The formula can be cross checked by totalling the weight of the original scrap and the weight of the Fine Gold addition then multiplying the weight of the original scrap by the assayed Gold percentage to determine its Fine Gold content and then add the weight of the additional Fine Gold to determine the total Fine Gold content.

Multiplying the total weight of the batch by the desired or targeted Gold content.

Finally comparing the Fine Gold content from the above two calculations:

500 + 80.00 = 580.00gms

500 x 71.0% = 355 + 80.00 additional grams of Fine Gold
= Total of 435.00gms Fine Gold

580 x .750 = 435.00gms Fine Gold

Soldering

Soldering

Soldering is a method of joining two pieces of metal using a molten filler metal to fill the gap and to alloy with the parent metals without the parent metals melting. The flow of solder into the gap is due to capillary action. Thus, the filler metal (solder) must have a different composition to the parent metals being joined. The solder alloy, therefore, has a liquidus temperature lower than the solidus temperature of the parent metals. This difference should be at least 50°C.

In the jewellery industry, soldering should be more correctly described as 'hard soldering' or brazing, as the solder alloys have melting ranges in excess of 450°C. Soldering produces good strong joints. Lead-Tin solders are soft solders and should never be used on Gold jewellery, not even for repair work, as Lead readily contaminates and embrittles carat Golds.

The strength of the soldered joint depends on the joint gap, becoming stronger at small gaps.

Wetting of the joint gap by the solder is important for successful soldering. Thus, clean, grease and oxide-free surfaces are essential.

Joint Design and Gap

The geometry of the joint also influences the strength of the final soldered joint. A simple butt joint is the weakest. A scarf joint, where the ends are angled or lap joints are preferred when strength is a factor.

T-joints with one end inserted into the other will provide the strongest joint.

Joint gap for optimum soldering is about 0.02mm to 0.15mm.

Cleaning the Surfaces

Oil and grease should be removed in a degreasing solvent, preferably in an ultrasonic bath. Oxide films and dirt can be removed using an acid pickle or by mechanical abrasion, using a file or emery paper to produce a bright surface.

Always ensure adequate ventilation and avoid breathing in the fumes from any cleaning operation.

Use of Flux

Flux is a chemical compound which is applied to the joint surfaces to clean them by helping to remove any oxides and dirt and then, during soldering, to provide a protective layer to help prevent re-oxidation during heating. This promotes wetting of the joint surfaces by the molten solder as it flows through the gap. The flux must be molten and active before the solder melts and should remain active until the solder has solidified.

The most common fluxes used in Gold jewellery are Borax (Sodium Tetraborate) and Boric Acid. These are usually mixed to a paste with water and applied to the joint and solder prior to heating. Borax powder is preferentially mixed with alcohol.

When low carat Gold solders are used, it may be necessary to use fluxes with lower melting temperature ranges. For this reason, commercial fluxes are preferred. They are available as powder, cones, in liquid forms or as ready-made pastes. Powder is normally mixed with water to a paste prior to use. These fluxes are based on potassium borofluoride compounds, sometimes with silicofluorides, and are tailored to have a range of properties for different applications. Use of potassium-based fluxes avoids the yellow glare in the torch associated with Sodium compounds.

Fluxed joints should be heated gently at first to boil off the water and to minimise spitting of the flux. As the temperature is raised, the flux first becomes milky and later clear and active.

Jigging of the Joints

It is necessary to ensure the parts being soldered are in the correct position and do not move during the soldering operation. This may be achieved simply by gravity, with one part resting on the other, but often, some form of clamp or jig is required to ensure correct positioning. Clamps and jigs should preferably be poor conductors of heat to avoid excessive heat loss. They should also allow for expansion and contraction.

Some pieces such as hollow stampings may be held together with Copper or stainless steel wire bound around them, but care must be taken to avoid soldering these wires to the piece. Steel clips of special design are very suitable for this application and are re-usable.

Electric resistance or laser tack welding is another method that can be used to hold the joints together; with the increased acceptance of laser welders this technique is becoming increasingly popular. Graphite based fixture boards are also used in furnace soldering.

Stopping Off

To prevent the molten solder flowing into areas where it is not wanted, it is sometimes useful to stop off the areas with a 'paint' made from a paste of jewellers rouge or colloidal graphite.

Soldering

The torch should be focused to uniformly heat the parts to be joined, not on the solder itself. When the parts are hot enough, touching the solder to the joint will cause it to heat up, melt and flow into the joint. Preferably, the other end of the joint is a little hotter, rather than cooler to avoid premature solidification of the solder before it has flowed throughout the joint area.

Once the solder has flowed, remove the heat and allow the joint to cool and solidify.

Flux residues are usually easily removed in water. Light brushing may help. Any oxides that have formed around the joint can be removed by pickling.

Traditionally, solder is placed at the joint in the form of small pieces of thin sheet (paillons) or fed to the joint as wire. The problem can be to ensure that the solder remains in the correct place and only the correct amount is used. Increasingly, Solder Paste is preferred as the right amount can be placed in the right location, without wastage and soldering is generally quicker more reliable and more cost effective.

Forms of Solder

The use of solder in small pieces of thin sheet or as wire has been mentioned. Solder can also be used in other forms.

Solder-Filled Wire: This is carat Gold wire for chain-making containing a core of solder (of the same carat) down the centre. It is used to solder the formed links in a belt furnace.

Solder Flush Strip: This is a carat Gold sheet containing a layer of solder, 5% - 15% by weight, bonded to one side. It is well suited to stampings that are subsequently soldered in a belt furnace without any additional solder.

Solder Paste: Solder Pastes are homogenised mixtures of solder in the form of a very fine carat Gold solder powder combined with an organic binder which may or may not contain a flux, depending on whether torch heating will be used or furnace heating where a protective atmosphere is present. The paste is dispensed from plastic syringes using a hollow needle of appropriate size. The syringes can be fitted to a hand-held dispenser or to an electro-pneumatic actuated dispenser which uses compressed air to actuate the dispenser for a pre-determined time to deliver an exact and reproducible amount of paste to the joint. Where precise control is not required, the simpler hand operated dispensers are used. Solder Pastes can be supplied in all the most common carats up to and including 22ct. They do cost more than solder in the conventional wire and strip forms but there are considerable benefits:

- A saving in time
- An exact control on the amount of solder to be used
- Less wastage of expensive solder alloy
- Reduced reject rate or complete elimination of poorly formed joints

- More precise positioning of solder compared with using paillons
- Increased production rates
- Possibility of semi-automation
- Unskilled personnel can be easily trained to use the dispensers. The pastes, which are supplied in their dispensers, have a long shelf life even when partially used

Solders

There are a range of solders on the market to meet all demands in terms of carat, colour and melting ranges. For each carat, plumb solders are available, so that soldered jewellery meets the fineness standards.

Grades

For each carat there is a range of grades, typically hard, medium, easy and even extra-easy. These designations refer to relative melting or flow temperatures of the solder. A medium solder has a lower melting temperature than a hard grade, an easy grade even lower and extra easy much lower. Such grades are useful when several solder joints are being made, so one starts with the hard grade for the first joint and then uses the medium for the second and so on. This practice reduces the risk of remelting previous solder joints. When repairing a damaged item of jewellery, the repairer will probably opt for an extra easy grade to be sure not to remelt existing soldered joints.

Solder compositions for both coloured and white Golds are based on conventional jewellery alloys to which low melting point alloying metals are added to reduce their melting temperatures. These additions, for example, include Zinc, Cadmium and Indium. They must be used in carefully controlled amounts to impart the desired performance in the solder.

Cadmium: Traditionally, Cadmium has been commonly used in solder alloys but, unfortunately, it is now known that there is a serious toxicity problem with Cadmium. It has a low melting point of 321°C, boils at 767°C and has a high vapour pressure. This means that it readily forms a vapour that reacts with air to form a poisonous Cadmium oxide fume. Exposure to this fume can cause long term health problems to workers in the jewellery industry including scrap refiners. Although good ventilation and exhaust systems should always be in place in a workshop, escape of Cadmium into the atmosphere causes environmental pollution and can get into the food chain. Many governments have banned the use of Cadmium in solder alloys or placed severe restrictions on its use in the workshop.

Fortunately, much research and development work has been done during the last decade to produce solder alloys, including pastes, of all carats up to 22ct, which are Cadmium-free. These work just as well as Cadmium solders but may require the soldering technique to be adjusted a little.

Solder Tips

Each jeweller will have their own 'tricks of the trade' but some useful tips that are of proven benefit are detailed below:

- When obtaining new solders, use a scribe to mark the colour on the bottom edge of one side and the solder type on the other. Then use the solder at the end opposite from the scribe marks. Thus, when you get down to the smallest piece, you will know what it is
- Clean sheet solder with pickle, then rinse with straight denatured alcohol
- Clean used or worn jewellery first in an ultrasonic cleaner. Then, clean in pickle and coat with flux such as a Boric Acid/denatured alcohol solution. When using Solder Paste, apply the solder first, then the flux solution
- Ignite the boric/alcohol flux coating to produce a protective glaze that inhibits oxidation

- If sizing a ring, you should ensure a flush fit at the joint, which should be as clean as possible. Neglecting either of these steps will usually result in pits
- Apply heat uniformly to the article, then to the piece of solder. When using Solder Paste, simply apply heat to the article. If solder is overheated, pits may result from burning off alloy additions
- Apply flux as needed at the solder joint to induce solder flow (not needed for torch Solder Paste)
- Solder flow can be stopped from flowing where you don't want it by using tripoli, yellow ochre, a graphite pencil, stop off, or garlic. To tell if a ring has been soldered, heat it with a torch flame until a light oxide forms; the solder will stand out
- If carrying out a repair and you wish to avoid overheating sensitive areas, e.g. containing gemstones, mask these areas with a wet tissue or cotton wool
- When performing multiple soldering operations on a piece, start with a high temperature solder (hard) for first operation, then move down in temperature (medium or easy) for subsequent soldering
- Minimise gaps between parts to be assembled
- Always use a well ventilated area and make sure the solder you choose doesn't have a higher flow point than the article you are soldering

White Gold Scale

Until now, there has not been a clear definition of what constitutes a white Gold. A recent initiative of the Manufacturing Jewellers & Suppliers of America and supported by the World Gold Council has led to the launch of a set of guidelines to define the colour of white Gold. These voluntary industry guidelines are expected to be adopted internationally.

In an effort to help you make your choices when ordering white Gold jewellery alloys, Peter W Beck Pty Ltd has adopted the guidelines to define the colour of our white Golds.

Although many white Golds can look similar they have subtle colour differences, their colour variances can be measured quantitatively using a colour spectrophotometer. The degree of whiteness of a white Gold can be described in terms of a numerical value called the ASTM Yellowness Index D1925. White Gold has been defined as having a Yellowness Index value of 32.0 or less and measurements are carried out under specific lighting conditions.

Grades of White Gold

Within the ASTM Yellowness Index D1925 three grades of white Gold are defined:

GRADE 1 (Premium grade) - these alloys have a good white colour and do not need Rhodium plating

GRADE 2 (Standard grade) - reasonable white colour; Rhodium plating is optional for these alloys

GRADE 3 (Off-white colour) - such alloys need to be Rhodium plated

Any alloys falling outside of these three grades are classed as non-white. In terms of the Yellowness Index, these grades can be defined as follows:

For many retailers and manufacturers, quantitative measurement of white Golds for whiteness, using a colour spectrophotometer instrument is not practical or economical. This problem has been overcome by **The Whiteness Index**, a colour chart developed by the colour technology laboratory of Gretag-Macbeth Inc. This colour chart incorporates seven metal samples which span the range of Yellowness Index values and represent the three grades of whiteness. Using the correct lighting conditions, the Whiteness Index enables a quick and easy comparison of the whiteness of a piece of white Gold against the samples therefore facilitating an estimate of which grade it is and its approximate Yellowness Index value.

Grade	Yellowness Index Value
Grade 1 (Premium)	< 19.0
Grade 2 (Standard)	19.0 - 24.5
Grade 3 (Off White)	24.5 - 32.0
Non White	> 32.0

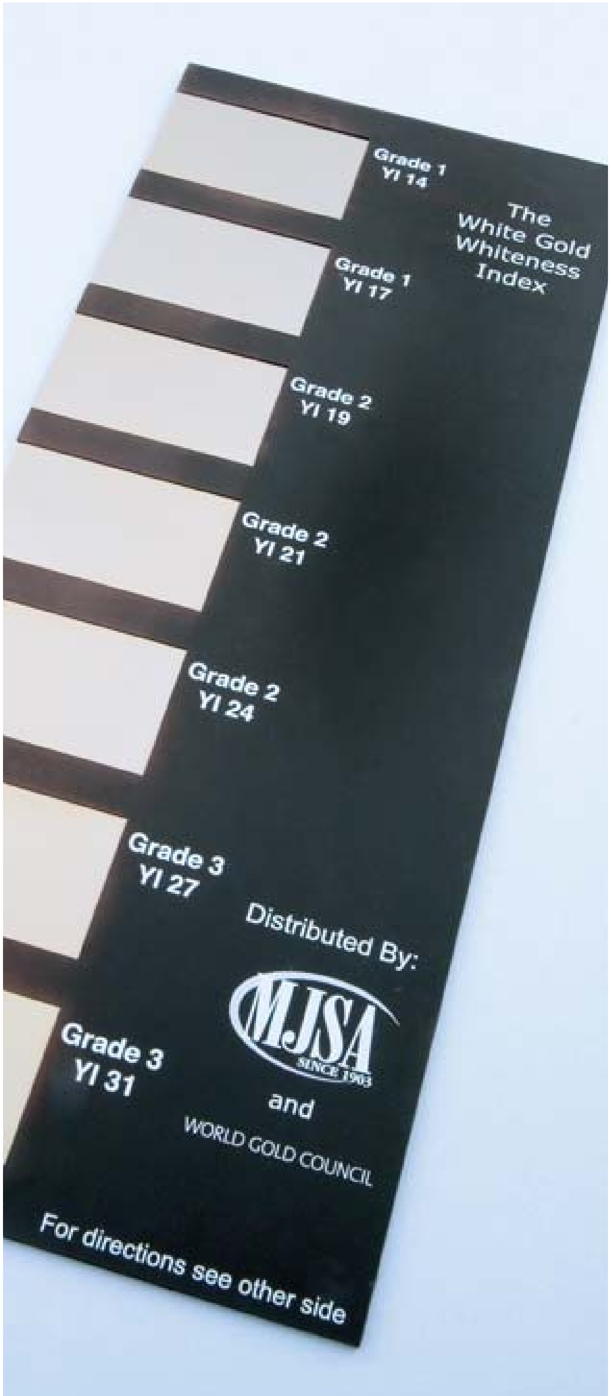
Practical Application

It is envisaged that manufacturing jewellers will become increasingly aware of this scale and will use the information to assist them when comparing and selecting the appropriate white Gold to use for a specific application. Of particular importance, the Whiteness Index indicates the need to Rhodium plate an article or that it is optional because of the premium grading of the alloy.

The Peter W Beck Pty Ltd range of white Golds have been graded using The Whiteness Index. We hope this will help you when choosing white Gold alloys.

The White Gold Standard Index may be purchased from the Jewellers Association of Australia.

THE IMAGE BELOW IS A PHOTOGRAPHIC REPRODUCTION OF THE WHITE GOLD STANDARD, AS SUCH, IT IS NOT SUITABLE FOR COLOUR COMPARISONS



White Gold Alloys

Alloy	YI Value
18W	19
18GP	17
18WGF	14
18SA	19
18N	14
14W	17
10W	14
9W	14
9GP	19
9SA	17
9N	14
BSA	14

Comparative White Metals

Alloy	YI Value
STG SILVER	14
PT 960	14
RHODIUM	14

Density of Commonly Used Jewellery Alloys & Elements

Code	Description	Density
22Y	22ct Yellow	17.86
18Y	18ct Yellow	15.51
18P	18ct Pink	15.17
18W	18ct White	15.64
18SA	18ct Setting Alloy	17.39
18GP	18ct General Purpose	15.90
14Y	14ct Yellow	12.96
14P	14ct Pink	13.09
14W	14ct White	13.87
10Y	10ct Yellow	11.48
10P	10ct Pink	11.20
10W	10ct White	12.84
9Y	9ct Yellow	11.16
9P	9ct Pink	11.23
9W	9ct White	12.55
9SA	9ct Setting Alloy	13.38
SS	Sterling Silver	10.36
PT950RU	950 Platinum Ruthenium	20.70
PT960	960 Platinum Copper	20.32
PT970	970 Platinum Copper	20.59
PD950AG	950 Palladium Silver	11.80
24Y	Gold	19.32
FS	Silver	10.49
PLAT	Platinum	21.45
PALL	Palladium	12.02

To convert the weight of a known alloy to the weight of another alloy it is a simple matter of comparing the densities of the alloys and can be expressed by the following formula:

$$\frac{\textbf{Density of the target alloy}}{\textbf{Density of the known alloy}} \textbf{ x weight of known alloy = weight of target alloy}$$

For example, to find the equivalent weight of an article in 9ct Yellow when the known weight is say 50gms in 18ct Yellow:

An article in 18ct Yellow weighs 50gms: $\frac{11.16}{15.51}$ x 50 = 35.97gms in 9ct Yellow

For example, to find the equivalent weight of an article in 18ct Yellow when the known weight is say 50gms in 9ct Yellow:

An article in 9ct Yellow weighs 50gms: $\frac{15.51}{11.16}$ x 50 = 69.49gms in 18ct Yellow

Gold Alloy Fineness

As Fine Gold is known as 24 carat, the percentage of Fine Gold in an alloy can be calculated by the following formula:

$$\frac{\textbf{Carat of Gold Alloy}}{\textbf{24}} \textbf{ x 100 = \% of Fine Gold}$$

For example: $\frac{18}{24}$ x 100 = 75% of Fine Gold

For example: $\frac{9}{24}$ x 100 = 37.5% of Fine Gold

Carat Weight Conversion Table

	TO	24Y	22Y	22P	18Y	18P	18W	18GP	18WGF	14Y	14W	14P	9Y	9P	9W	9GP	FS	SS	925AG	18SA	BSA	9SA	ESA	18N	9N	PT960	PT970	PT950RU
FROM	24Y	1.000	0.924	0.913	0.803	0.785	0.810	0.823	0.817	0.671	0.869	0.678	0.578	0.581	0.650	0.662	0.543	0.536	0.533	0.900	0.705	0.693	0.613	0.765	0.605	1.052	1.066	1.071
FROM	22Y	1.082	1.000	0.987	0.868	0.849	0.876	0.890	0.884	0.726	0.940	0.733	0.625	0.629	0.703	0.716	0.587	0.580	0.576	0.974	0.763	0.749	0.663	0.828	0.655	1.138	1.153	1.159
FROM	22P	1.096	1.013	1.000	0.880	0.860	0.887	0.902	0.896	0.735	0.952	0.742	0.633	0.637	0.712	0.725	0.595	0.588	0.584	0.986	0.773	0.759	0.672	0.838	0.663	1.153	1.168	1.174
FROM	18Y	1.246	1.152	1.137	1.000	0.978	1.008	1.025	1.018	0.836	1.082	0.844	0.720	0.724	0.809	0.825	0.676	0.668	0.663	1.121	0.879	0.863	0.763	0.953	0.754	1.310	1.328	1.335
FROM	18P	1.274	1.177	1.162	1.022	1.000	1.031	1.048	1.041	0.854	1.106	0.863	0.736	0.740	0.827	0.843	0.691	0.683	0.678	1.146	0.898	0.882	0.780	0.974	0.771	1.339	1.357	1.365
FROM	18W	1.235	1.142	1.127	0.992	0.970	1.000	1.017	1.010	0.829	1.073	0.837	0.714	0.718	0.802	0.818	0.671	0.662	0.658	1.112	0.871	0.855	0.757	0.945	0.747	1.299	1.316	1.324
FROM	18GP	1.215	1.123	1.109	0.975	0.954	0.984	1.000	0.993	0.815	1.055	0.823	0.702	0.706	0.789	0.804	0.660	0.652	0.647	1.094	0.857	0.842	0.745	0.930	0.735	1.278	1.295	1.302
FROM	18WGF	1.224	1.131	1.117	0.982	0.961	0.991	1.007	1.000	0.821	1.063	0.829	0.707	0.711	0.795	0.810	0.664	0.656	0.652	1.101	0.863	0.847	0.750	0.936	0.740	1.287	1.304	1.311
FROM	14Y	1.491	1.378	1.360	1.197	1.171	1.207	1.227	1.218	1.000	1.295	1.010	0.861	0.867	0.968	0.987	0.809	0.799	0.794	1.342	1.052	1.032	0.914	1.140	0.902	1.568	1.589	1.597
FROM	14W	1.151	1.064	1.051	0.924	0.904	0.932	0.948	0.941	0.772	1.000	0.780	0.665	0.669	0.748	0.762	0.625	0.617	0.613	1.036	0.812	0.797	0.706	0.881	0.697	1.211	1.227	1.234
FROM	14P	1.476	1.364	1.347	1.185	1.159	1.195	1.215	1.206	0.990	1.282	1.000	0.853	0.858	0.959	0.977	0.801	0.791	0.786	1.328	1.041	1.022	0.905	1.129	0.893	1.552	1.573	1.581
FROM	9Y	1.731	1.600	1.580	1.390	1.359	1.401	1.425	1.415	1.161	1.504	1.173	1.000	1.006	1.125	1.146	0.940	0.928	0.922	1.558	1.221	1.199	1.061	1.324	1.047	1.821	1.845	1.855
FROM	9P	1.720	1.590	1.570	1.381	1.351	1.393	1.416	1.406	1.154	1.494	1.166	0.994	1.000	1.118	1.139	0.934	0.923	0.916	1.549	1.214	1.191	1.054	1.316	1.041	1.809	1.833	1.843
FROM	9W	1.539	1.423	1.405	1.236	1.209	1.246	1.267	1.258	1.033	1.337	1.043	0.889	0.895	1.000	1.019	0.836	0.825	0.820	1.386	1.086	1.066	0.943	1.178	0.931	1.619	1.641	1.649
FROM	9GP	1.511	1.396	1.378	1.213	1.186	1.223	1.243	1.235	1.013	1.312	1.023	0.873	0.878	0.981	1.000	0.820	0.810	0.805	1.360	1.066	1.046	0.926	1.156	0.914	1.589	1.610	1.618
FROM	FS	1.842	1.703	1.681	1.479	1.446	1.491	1.516	1.505	1.235	1.600	1.248	1.064	1.071	1.196	1.219	1.000	0.988	0.981	1.658	1.299	1.276	1.129	1.409	1.114	1.937	1.963	1.973
FROM	SS	1.865	1.724	1.702	1.497	1.464	1.510	1.535	1.524	1.251	1.620	1.264	1.077	1.084	1.211	1.235	1.013	1.000	0.993	1.679	1.316	1.292	1.143	1.427	1.128	1.961	1.987	1.998
FROM	925AG	1.878	1.736	1.713	1.507	1.474	1.520	1.545	1.534	1.259	1.631	1.272	1.085	1.091	1.220	1.243	1.019	1.007	1.000	1.690	1.325	1.300	1.151	1.436	1.136	1.975	2.001	2.012
FROM	18SA	1.111	1.027	1.014	0.892	0.872	0.899	0.914	0.908	0.745	0.965	0.753	0.642	0.646	0.722	0.735	0.603	0.596	0.592	1.000	0.784	0.769	0.681	0.850	0.672	1.168	1.184	1.190
FROM	BSA	1.417	1.310	1.293	1.138	1.113	1.147	1.167	1.158	0.951	1.231	0.960	0.819	0.824	0.921	0.938	0.770	0.760	0.755	1.276	1.000	0.982	0.869	1.084	0.858	1.491	1.511	1.519
FROM	9SA	1.444	1.335	1.318	1.159	1.134	1.169	1.188	1.180	0.969	1.254	0.978	0.834	0.839	0.938	0.956	0.784	0.774	0.769	1.300	1.019	1.000	0.885	1.105	0.874	1.519	1.539	1.547
FROM	ESA	1.632	1.508	1.489	1.310	1.281	1.321	1.343	1.334	1.095	1.417	1.106	0.943	0.948	1.060	1.080	0.886	0.875	0.869	1.469	1.151	1.130	1.000	1.248	0.987	1.716	1.739	1.748
FROM	18N	1.307	1.208	1.193	1.049	1.026	1.058	1.076	1.068	0.877	1.135	0.886	0.755	0.760	0.849	0.865	0.710	0.701	0.696	1.177	0.922	0.905	0.801	1.000	0.791	1.375	1.393	1.401
FROM	9N	1.653	1.528	1.508	1.327	1.298	1.338	1.360	1.351	1.109	1.435	1.120	0.955	0.961	1.074	1.094	0.897	0.886	0.880	1.488	1.166	1.145	1.013	1.264	1.000	1.738	1.761	1.771
FROM	PT960	0.951	0.879	0.868	0.763	0.747	0.770	0.782	0.777	0.638	0.826	0.644	0.549	0.553	0.618	0.629	0.516	0.510	0.506	0.856	0.671	0.658	0.583	0.727	0.575	1.000	1.013	1.019
FROM	PT970	0.938	0.867	0.856	0.753	0.737	0.760	0.772	0.767	0.629	0.815	0.636	0.542	0.545	0.610	0.621	0.509	0.503	0.500	0.845	0.662	0.650	0.575	0.718	0.568	0.987	1.000	1.005
FROM	PT950RU	0.933	0.863	0.852	0.749	0.733	0.756	0.768	0.763	0.626	0.811	0.632	0.539	0.543	0.606	0.618	0.507	0.500	0.497	0.840	0.658	0.646	0.572	0.714	0.565	0.982	0.995	1.000

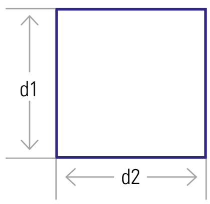
"FROM" WEIGHT x "TO" CONVERSION FACTOR = DESIRED WEIGHT

FOR EXAMPLE, TO FIND OUT HOW MUCH A STERLING SILVER ARTICLE OF 5.00GMS WOULD WEIGH IN 9CT YELLOW GOLD, FOLLOW ALONG THE "FROM SS" ROW UNTIL IT INTERSECTS THE "TO 9Y" COLUMN. THIS IS THE FIGURE YOU MULTIPLY BY YOUR STERLING SILVER WEIGHT.

5.00GMS x 1.077 = 5.385GMS. THE 5.00GM STERLING SILVER ARTICLE WOULD WEIGH 5.385GMS IN 9CT YELLOW GOLD.

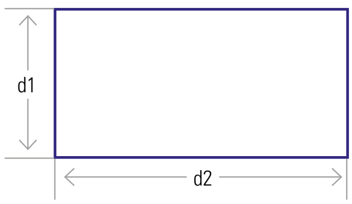
Area & Volume Calculations

π = 3.14159



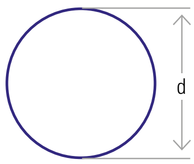
Square

A = d1 x d2



Rectangle

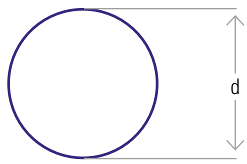
A = d1 x d2



Circle

A = d^2 x 0.7854

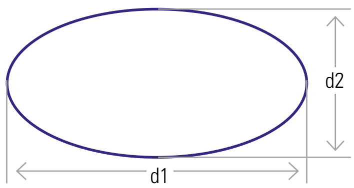
Circ. = πd



Sphere

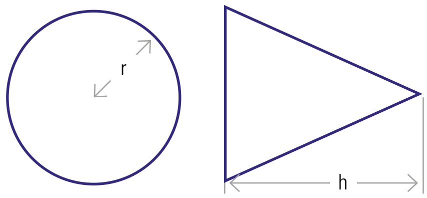
A = d^2 x 3.14159

V = d^3 x 0.5236



Ellipse

A = d1d2 x 0.7854

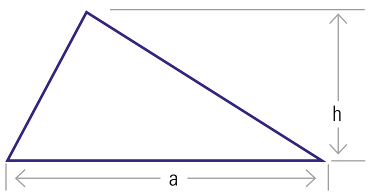


Cone

A (conical surface) =

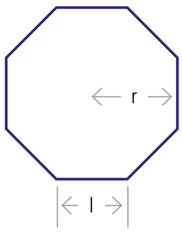
$\pi r \sqrt{r^2+h^2}$

$V = \frac{\pi r^2 h}{3}$



Triangle

A = $\frac{ah}{2}$

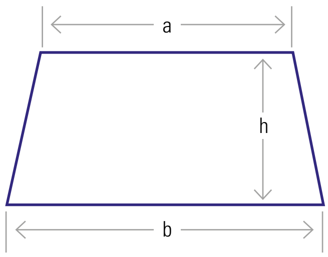


Polygon - Regular

A = $\frac{rlN}{2}$ **where N = number of sides**

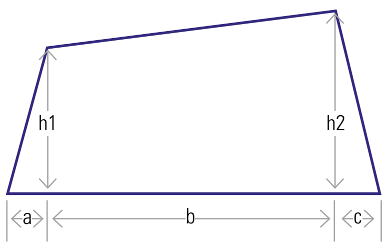
Polygon - Irregular

Divide into triangles and calculate aggregate areas of the resulting triangles



Trapezoid

A = $\frac{h(a + b)}{2}$



Trapezium

A = $\frac{b(h1 + h2) + ah1 + ch2}{2}$

PETER W BECK

Weights & Measures

To Change From	To	Multiply By
Carats	Grams	0.2
Centimetres	Inches	0.3937
Cubic Centimetres	Cubic Millimetres	1000
Cubic Centimetres	Cubic Inches	0.061023
Cubic Inches	Cubic Centimetres	16.3872
Feet	Centimetres	30.4801
Feet	Metres	.30480
Feet	Inches	12
Grams	Carats	5
Grams	Kilograms	0.001
Grams	Milligrams	1000
Grams	Ounces, Avoir	.03527394
Grams	Ounces, Troy	.03215072
Grams	Pounds, Troy	.0026792272
Inches	Centimetres	2.54001
Inches	Millimetres	25.4001
Kilograms	Grams	1000
Kilograms	Milligrams	1000000.0
Kilograms	Ounces, Avoir	35.2740
Kilograms	Ounces, Troy	32.150727
Kilograms	Pounds, Avoir	2.20462
Kilograms	Pounds, Troy	2.67922725
Metres	Centimetres	100
Metres	Feet	3.2808
Metres	Inches	39.37
Milligrams	Grams	.001
Milligrams	Kilograms	.000001
Milligrams	Ounces, Avoir	.00003527
Milligrams	Ounces, Troy	.00003215
Milligrams	Pounds, Avoir	.0000022
Milligrams	Pounds, Troy	.0000026792
Millimetres	Centimetres	0.1
Millimetres	Inches	.03937
Millimetres	Metres	.001
Ounces, Avoir	Grams	28.3495
Ounces, Avoir	Kilograms	.02835
Ounces, Avoir	Milligrams	28349.5
Ounces, Avoir	Ounces, Troy	.911458
Ounces, Avoir	Pounds, Avoir	.0625
Ounces, Avoir	Pounds, Troy	0.7595485
Ounces, Troy	Grams	31.103495
Ounces, Troy	Kilograms	.03110349
Ounces, Troy	Milligrams	31103.495
Ounces, Troy	Ounces, Avoir	1.0971428
Ounces, Troy	Pounds, Troy	.08333333
Ounces, Troy	Pounds, Avoir	1.0971428

Common Elements

Common Name	Chemical Symbol	Melting Point °C	Specific Gravity
Aluminium	Al	660	2.7
Antimony	Sb	630	6.62
Beryllium	Be	1282	1.82
Bismuth	Bi	271	9.8
Cadmium	Cd	321	8.65
Carbon	C	N/A	2.22
Chromium	Ch	1888	7.19
Cobalt	Co	1495	8.85
Copper	Cu	1083	8.96
Gold	Au	1063	19.32
Iridium	Ir	2454	22.5
Iron	Fe	1539	7.87
Lead	Pb	328	11.34
Magnesium	Mg	650	1.74
Molybdenum	Mo	2625	10.2
Nickel	Ni	1455	8.9
Osmium	Os	2700	22.5
Palladium	Pd	1552	12
Platinum	Pt	1769	21.45
Rhodium	Rh	1967	12.44
Ruthenium	Ru	2310	12.45
Silicon	Si	1430	2.33
Silver	Ag	961	10.49
Tin	Sn	232	7.3
Zinc	Zn	419	7.13

To convert °C to °F = $\frac{°C \times 9 + 32}{5}$

To convert °F to °C = $\frac{°F - 32 \times 5}{9}$

1 millilitre of distilled water at 4°C weighs 1 gram.

Ring Blank Length Calculation

Wheatsheaf Size	Inside Diameter (mm)	Metric Size (mm)	At 2mm Thick	At 1.5mm Thick	At 1.25mm Thick	At 1mm Thick	At 0.75mm Thick	At 0.5mm Thick
C	12.8	40.2	46.5	44.9	44.1	43.4	42.6	41.8
D	13.2	41.5	47.8	46.2	45.4	44.6	43.8	43.0
E	13.6	42.7	49.0	47.4	46.7	45.9	45.1	44.3
F	14.0	44.0	50.3	48.7	47.9	47.1	46.3	45.6
G	14.4	45.2	51.5	50.0	49.2	48.4	47.6	46.8
H	14.8	46.5	52.8	51.2	50.4	49.6	48.9	48.1
I	15.2	47.8	54.0	52.5	51.7	50.9	50.1	49.3
J	15.6	49.0	55.3	53.7	52.9	52.2	51.4	50.6
K	16.0	50.3	56.5	55.0	54.2	53.4	52.6	51.8
L	16.4	51.5	57.8	56.2	55.4	54.7	53.9	53.1
M	16.8	52.8	59.1	57.5	56.7	55.9	55.1	54.3
N	17.2	54.0	60.3	58.7	58.0	57.2	56.4	55.6
O	17.6	55.3	61.6	60.0	59.2	58.4	57.6	56.9
P	18.0	56.5	62.8	61.3	60.5	59.7	58.9	58.1
Q	18.4	57.8	64.1	62.5	61.7	60.9	60.2	59.4
R	18.8	59.1	65.3	63.8	63.0	62.2	61.4	60.6
S	19.2	60.3	66.6	65.0	64.2	63.5	62.7	61.9
T	19.6	61.6	67.9	66.3	65.5	64.7	63.9	63.1
U	20.0	62.8	69.1	67.5	66.8	66.0	65.2	64.4
V	20.4	64.1	70.4	68.8	68.0	67.2	66.4	65.7
W	20.8	65.3	71.6	70.1	69.3	68.5	67.7	66.9
X	21.2	66.6	72.9	71.3	70.5	69.7	69.0	68.2
Y	21.6	67.9	74.1	72.6	71.8	71.0	70.2	69.4
Z	22.0	69.1	75.4	73.8	73.0	72.3	71.5	70.7
Z+1	22.4	70.4	76.7	75.1	74.3	73.5	72.7	71.9
Z+2	22.8	71.6	77.9	76.3	75.6	74.8	74.0	73.2
Z+3	23.2	72.9	79.2	77.6	76.8	76.0	75.2	74.5
Z+4	23.6	74.1	80.4	78.9	78.1	77.3	76.5	75.7
Z+5	24.0	75.4	81.7	80.1	79.3	78.5	77.8	77.0
Z+6	24.4	76.7	82.9	81.4	80.6	79.8	79.0	78.2

Bangle Length Calculation

The following formula will calculate the length of wire needed to produce a bangle of a desired inside diameter and a known wire diameter:

(ID + D) x π **ID** = the inside diameter of the bangle
D = the diameter of the wire
π = Pi = 3.14159

Therefore, to calculate the length of wire needed to produce a bangle of 60mm inside diameter from 4mm round wire:

(60 + 4) x 3.14159

64 x 3.14159 = 201mm is the length of wire needed to produce the above bangle.

Glossary

Peter W Beck Precious Metal Services®

Toll Free 1800 888 590
Telephone 08 8440 3399
Facsimile 08 8447 1144
Email preciousmetals@pwbeck.com.au
Web www.pwbeck.com.au

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Peter W Beck Precious Metal Services®

Toll Free 1800 888 590
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Email preciousmetals@pwbeck.com.au
Web www.pwbeck.com.au

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Age Hardening
A thermal treatment to confer additional hardening in Copper containing carat Golds. Usually performed after jewellery assembly. Comprises a high temperature solution anneal followed by water quenching and then a low temperature ageing treatment for a specified time. Also known as precipitation hardening, it is applicable to 18 and lower carat Golds, Sterling Silver and some Platinum alloys are also age hardenable.

Alloy, Alloying
A combination of two or more metals, usually by melting them together to produce an alloy with resulting properties that are better than the constituent metals on their own.

Annealing, Fully Anneal
Restoring a metal to a soft ductile condition after work hardening or deformation. It is usually recommended that annealing take place after a metal has been cold worked by approximately 50% to 70%. Annealing is achieved by heating the metal to a temperature for a period of time which allows the recrystallisation of the metal/alloy. Fine Gold will recrystallise at 200°C but most Gold alloys are fully annealed at a temperature between 550°C and 750°C.

Anode
The positive electrode in an electroplating or electroforming process. It can supply metal into the electrolyte.

Assay
The destructive analysis of precious metal alloys to determine the precious metal fineness content of a said sample or article.

Atmospheric Control
Providing a protective gaseous atmosphere during heating or melting processes to a metal or alloy to ensure the exclusion of Oxygen which could potentially cause oxidation of the base metals in an alloy, resulting in scale formation and possible failure during subsequent manufacture.

Base Metal
Metals other than Gold, Silver and the Platinum group metals that are associated with precious metals mostly through alloying e.g. Copper, Zinc, Nickel, etc.

Bead Blasting
A cleaning process conducted after the casting stage of lost wax casting. The cast tree is pressure cleaned with water and compressed air containing an aggregate (glass beads) to remove any left over investment and oxides and leaves a satin finish.

Bead Setting
A stone setting technique whereby a stone is seated into a setting or into a prepared recess and metal beads are raised around the stone using a tool, called a graver, which perform the function of holding the stone in place.

Bench Sweep
Low grade precious metal containing waste with a high percentage of discarded aids to manufacture, for example, mops, burs, saw blades, emery paper etc. Typically a bench sweep would contain a small amount of lemel by volume.

Bezel Setting
A stone setting technique whereby a stone is seated into a prepared recess and secured in place by wrapping a flat strip of metal around the gem and working the extreme edge to provide a secure restraint on the entire girdle of the stone.

Bullion
A term often confused with investment ingots of 99.99% purity. Bullion however, refers to unrefined or smelted precious metal cast into a bar for easy weighing, transport and handling.

Burnish
Process of achieving a semi-polished finish by deformation of the surface, e.g. by hammering. Can be done by machine, using porcelain balls or steel balls or needles (e.g. magnetic polisher) or by hand, using a burnisher.

Burnisher
A short handled tool used to lever/wipe metal over the edge of a stone in setting, achieving a semi-polished effect through working.

Button
The conical or tapered end of the central casting sprue, where the molten metal enters the investment mould. Acts as a source of molten metal to feed the casting during solidification.

Burn-Out
The process of kiln firing a refractory investment mould (part of the lost wax casting process), whereby the wax patterns in the mould are melted out and residues are burnt away at high temperature.

Carat
A measure of fineness of Gold; 24 carat = 100% pure, 18ct = 18/24 = 75% Gold content. Also a unit of weight for precious stones;
1 carat = 100 points = 0.2 gram.

Carborundum
Silicon Carbide, hardness 9.5 on Mohs scale. Used as a grinding or abrasive media.

Castability
The ability of an alloy to be melted, poured into a mould, retain sufficient fluidity, take an accurate impression of the mould cavity and be extracted without cracking. Difficult to quantify in a single test.

Casting Granules
Metal or alloy, in granular form for ease of melting. Typically used for investment casting, such alloys usually contain elements or combinations of elements that will improve fluidity and mould filling, inhibit oxidation and excessive grain growth in the cast piece, producing a higher quality finish than non casting type alloys.

Cathode
Negative electrode in an electroplating or electro-forming cell, often the component being plated or formed.

Centrifugal Casting
Uses centrifugal force to inject the melt from the crucible which is nearer to the centre of the spin-arm into the mould on the periphery. Arms may be coiled spring or electrically driven.

Charge
The metal/alloy loaded into a crucible ready for a melt. May be virgin metal or include recycled scrap.

Channel Setting
A setting technique for gemstones or diamonds that are arranged in a row along a precut channel. The stones are secured by placing their girdles into a groove that has been cut into the side of the channel.

Chasing
Hammering of a design on the face of an article with a tiny punch or chisel. Moulding in relief by working directly on the surface with a chasing hammer. The article is usually supported on a yielding surface such as wax or pitch.

Chenier
Metal tubing formed by either deep drawing followed by passing through a series of dies or by continuous casting and reducing the section through a series of draw plates or dies. Both techniques aim to produce parallel sided tube of continuous length and constant wall thickness.

Claw Setting
Claw setting is a classic style of setting and is possibly one of the most commonly used in engagement rings and other rings with a prominent center stone. The number of claws can vary in number with 3, 4, 5 and 6 being the most popular. The setter will secure the stone by cutting a bearing using a setting bur and then bends over the tips of the claws using a claw or prong pusher and finally cleans up the tips with a file or bur. Claw setting is also known as Solitaire Setting, Prong Setting and Tiffany Setting.

Cold Work(ed)
The process of mechanical deformation of a metal or alloy by reducing the cross section of a metal by rolling, forging, drawing or worked by bending at a temperature below the annealing temperature for the alloy so as to cause work or strain hardening. Most alloys will need to be cold worked by approximately 50% to 70% before annealing is necessary.

Collet
Small horizontal parallel sided ring, or with conical taper, to form a seat for the pavilion of the stone. Also a device used to hold small work during machining.

Colour
Carat Gold alloys can be referred to by a subjective colour description in conjunction with caratage, eg 18ct pink. Also a determinant for value of gemstones, eg diamond grading F-G Colour (degree of whiteness).

Cropping
The process of removing cast pieces from their parent tree by cutting through the sprue. Generally aided by pneumatic cutters.

Crucible
Vessel used for melting metals and alloys. Very stable at high temperatures exhibiting high thermal emissivity. Usually constructed of ceramic (Silicon Carbide, Alumina, etc) or Graphite.

Cupel
Refer to "Fire Assay".

De-Airing
Removal of bubbles from a slurry of mixed investment to avoid resulting positive defects on the surface of the castings. The process is done under vacuum, often with the aid of vibration.

Deep-Drawing
A deep pressing operation to produce a deep shape (cupping) by pressing a piece of sheet through a die under constant radial pressure. Often used to start the tube forming operation.

Density
The mass per unit volume of a metal or alloy, e.g. the density of Pure Gold is 19.32 grams per cubic centimetre. Density is numerically the same as specific gravity, the term used for mass per unit volume.

Doming (or Dapping)
Hammering sheet with a spherical ended punch down into a matching hemispherical hollow in a block to form a domed depression. After trimming, two matching domes may be soldered to form a hollow sphere.

Dross

Flux residues produced as a by product of melting and fluxing a metal or alloy, often appearing as a black, glassy, brittle material.

Ductility

Capability of a metal to be drawn or stretched without failure or fracture. In tensile testing it is measured as % elongation and % reduction in cross sectional area. It is related to malleability.

Electroforming

The electrodeposition of a metal onto an electrically conductive shaped substrate which acts as a cathode in the electroforming operation. The substrate acts as the template for a component of jewellery and sufficient metal is deposited to allow the subsequent removal of the substrate and the consequent use of the metal duplicate in jewellery manufacture.

Electroplating

The deposition of a metal onto a conductive substrate (cathode) via an electrolyte solution from an anode of the desired metal by passing an electric current through the system under a specific set of conditions defining the current and voltage.

Elongation (%)

A value given to express the extension of a particular gauge length of an alloy during deformation up to failure as a percentage of its original length. Gives an indication of the ductility of the alloy sample in its original state and can be compared to other alloys prepared in the same manner.

Embossing

Raising patterns in relief from the surface of a piece of sheet metal by hammering/punching from the back surface.

Emery

A natural abrasive superseded by synthetic Alumina (Corundum), often paper or cloth backed for controlled grinding.

Emissivity

The rate of loss of heat from a unit area in unit time at a given temperature (usually in the context of the surface of a melt). Very dependent on the temperature and the character of the surface.

Ethanol

Impure ethyl alcohol, a general purpose solvent used mainly for cleaning.

Feeding

The necessary process of feeding molten metal through sprues and gates into castings, to compensate for the contraction that castings exhibit as they cool and solidify. Can be assisted by gravity or by external gas pressure. Insufficient feeding will lead to shrinkage and porosity defects in the casting.

Final Assay

Analysis to determine percentage composition of relevant precious metals of individual jewellery components or average sample of an alloy to decide whether the hallmarking standard is achieved.

Finding

A commercially available or handmade fitting for jewellery assembly, including catches clasps, settings, swivels, hooks, earring wires etc.

Fineness

Precious metal content expressed in parts per thousand (by weight). For instance, 22ct Gold is 917 fine, 18ct is 750 fine, 9ct is 375 fine.

Fine Gold

Pure Gold 99.99 fineness, 24 carat; a level of purity commonly traded on the investment market and can only be achieved as a result of a refining operation.

Fire Assay

An accurate analytical method for determining the Gold content of a Gold bearing sample. It is the internationally accepted standard technique. Fire assay makes use of cupellation which is the process of using Lead, heat and air to facilitate the drawing of the base metals from the Gold bearing sample into the cupel crucible.

Fire Scale

Fire scale is caused by Oxygen combining with the Copper present in Silver Copper alloys such as Sterling Silver and may also occur in Gold alloys with a high Copper content. It is induced when the alloy is at an elevated temperature such as during alloying, annealing and soldering. It may only be a surface stain and can be polished out, however if the oxidation took place during alloying or over annealing it is more likely to now be an integral part of the alloy and will not polish out.

Flask

Outer stainless steel container of an investment casting mould, used in the investment casting process. The flask is reusable. Available in standard sizes, it provides a means for containing the wet slurry of investment until set, maintaining the integrity of the mould during the burnout stage in kilns at high temperatures and during casting.

Floor Sweep

The precious metal containing low grade wastes derived from sweeping the work area floors.

Fluidity

A term commonly applied to casting alloys. Fluidity is a complex property describing the ability of a molten alloy to run well into and take an accurate impression of the investment mould. Generally increases with superheat and freedom from oxidation. Evaluated by a variety of empirical cast test pieces such as grids.

Flux

A chemical mixture that performs the function of cleaning and protecting exposed metal surfaces during soldering, welding and melting of an alloy. Used in either solid, liquid or powder form it fuses at a lower temperature than the alloy and provides protection against oxidation, thus aiding wetting and metal flow during soldering.

Four 9s

This term is used to describe a precious metal, particularly Gold, having a purity of 99.99%, hence ‘Four Nines’.

Grain Boundary

The boundary surfaces between the crystals (grains) that make up a metal matrix. Most metals and alloys are polycrystalline, i.e. composed of many crystals or grains.

Grain Refinement

Addition of very small amounts, typically 0.01% of a nucleating agent e.g. Iridium or Cobalt to the alloy to promote a small grain size after casting or a recrystallisation anneal.

Grain Size

Not to be confused with granule size, this term refers to the average size of the crystals (known as ‘grains’) that make up the polycrystalline microstructure of an alloy after casting or recrystallisation (full annealing). The grain size influences strength, ductility and workability of metals and alloys.

Granulation

The formation of irregular shaped beads of metal or alloys prepared for the ease of remelting and weighing. The process requires molten metal to be poured from a height into a quenching fluid (commonly oil, water or water-ethanol mix). The molten alloy stream breaks up into beads above the quenching tank and upon hitting the surface of the quenching fluid.

Graver

A short narrow engraving tool for gouging metal, using a working face rather like a miniature chisel, used also in setting stones.

Half Hard

Refers to the finished temper of wrought metal such as wire and sheet. It is between fully annealed which is dead soft and fully hard which is approaching the maximum amount of cold working that leaves little or no ductility in the metal. The fully hard condition is usually found after the metal has been cold worked and as a result the cross section has been reduced by approximately 70% to 75% from either the cast ingot or the last anneal.

Hallmarking

The testing and stamping of Gold, Silver and Platinum pieces by the UK assay offices and subject to the UK Hallmarking Act, to signify fineness. Also applies to certain other countries with similar regulations, but the term is often applied unofficially in other countries where manufacturers self mark such as in Australia where the term Hallmarking may also be interchangeable with stamping of makers marks in jewellery pieces.

Hardness

The resistance of metal to indentation. Measured in a test using a standard indenter applied with a standard force. There are a number of test scales used to express the relative hardness of metals - HV120 is a hardness of 120 measured in the Vickers Diamond Penetration test. Brinell and Rockwell are other scales of hardness measurement used for metals, whereas the Mohs scale is used for gems and ceramics.

Heat Treatment

A thermal treatment applied to metals and alloys resulting in changed strength, hardness and ductility through a process of heating to a specified temperature for a specified time. Cooling rates may also be critical. This results in changing the microstructure of the sample. See also Age Hardening and Annealing.

Inclusions

In metallurgy it refers to a particle of foreign matter or an article that has become trapped within a piece of metal, this usually occurs during the melting and casting of an ingot or during the melting and casting of metal during the lost wax casting process.

Induction Heating, Melting

Heating and melting metal within a crucible by passing an alternating current at medium or high frequency through a water cooled Copper coil around the crucible and the metal. This current excites the atoms within the crucible and metal, resulting in heat generation and melting. Some stirring of the metal occurs from the effect of the induced electromagnetic forces.

Infra Red Radiation

Radiation of longer wavelength than visible red (750nm and above), not seen by the eye but nevertheless felt by the body as heat. More easily reflected than ultra violet.

Ingot

A solid cast bar of metal, often used to describe Gold in an investment bar form.

Investment

A fast setting slurry of Silica flour and binder used to create a mould impression of a wax pattern and forming, on firing, a refractory mould to receive a melt of Gold, Silver, Platinum or Palladium alloy, resulting in the reproduction of an original pattern with detailed accuracy. Binder may be ethyl silicate or acid phosphate.

Investment Casting

Refer to "Lost Wax Casting"

Invisible Setting

A setting technique used to set multiple princess cut stones into, by example, a ring top. The stones are arranged in rows and there may be two or more rows side by side. The finished effect is some what like Pavé in appearance, the major difference being that no claws, beads or metal surrounds are apparently holding the stones in place and hence the name invisible setting. The stones used in invisible setting must be specially prepared by cutting grooves into the stones just below the girdle; each stone has two grooves one each on the opposite sides of the stone. The stones are secured in two positions, the edge stones have their girdle set into a groove cut into the side of the setting in a manner similar to that used in Channel Setting. The centre stones are secured from underneath by placing the grooves cut into the stones onto support rails that have a very fine top edge and are perfectly aligned to the groove in the stones, by then tapping down from the top of the stone the fine edge of the under rail is forced to flare out into the groove and secures the stone in place.

Jigging

Temporary location of components to be soldered or welded, leaving clear access for torch, solder and flux. The jig prevents sagging or misalignment. Jigs are commonly clamps on arms with universal joints.

Lemel

Metal filings produced during jewellery making as a result of filing, sawing, grinding and sanding the working alloy. Lemel is usually approximately 90% metal by weight.

Liquidus

Refers to a line on a constitutional (phase) diagram of an alloy describing the temperature of an alloy as a function of composition above which the alloy is entirely molten.

Lost-Wax (Investment) Casting

A process used to reproduce metal castings with close tolerances from a wax pattern. Wax patterns, which may be an original hand carved wax, a CAD produced wax or waxes reproduced from a rubber mould are used to form a cavity within the investment material. These waxes are melted out early in the firing of the investment. This process leaves behind a void or voids within a refactory mould into which molten alloy is cast. This results in a metal reproduction of the original. This process is also known as investment casting.

Machinability

The relative ability of a metal to be cut in a machining operation using minimum power and producing a good surface finish.

Malleability

Capacity of a metal or alloy to be plastically deformed by hand working such as hammering or rolling extensively without inducing excessive work-hardening or cracking.

Master Alloy (Pre-Alloy)

Carat Gold alloys are a combination of Gold and other metals in specific proportions by weight. Collectively the other metals may be produced as a separate master (or pre-) alloy so that only Fine Gold need be added in the right proportion to make up the carat Gold alloy.

Master Patterns

Made from either metal, plastic or wax, the master pattern is the original design used to create a rubber, silicon or investment mould which is then used to replicate the design using the the lost wax casting process. Although the wax patterns are traditionally made from a hand carved piece of wax, new production techniques include patterns that have been designed using computer aided design (CAD) software and then produced by milling, wax plotting or stereo lithography.

Millegrain or Milgrain

A setting tool consisting of a fine milled wheel used to roll a millegrain border on an edge or bezel of a jewellery piece.

Mould

A hollow object, containing a cavity that is the outer form/shape of the pieces to be reproduced by wax injection or by metal casting. In the case of investment casting the mould can be made of various materials, e.g. metal or rubber for wax pattern production or refractory investment for casting metal.

Native Gold

Gold found in its natural metallic state, often as alluvial nuggets (water shed) or in seams of a host rock. Usually impure, the major impurity is usually Silver.

Negative Tolerance

Used in the context of standards of fineness, and (Hall)marking, a small compositional allowance, typically 0.3%, below the specified minimum fineness standard that is still acceptable in some countries.

Orange Peel Effect

A rumpled surface effect on metal after certain working operations due to a large grain size, it usually occurs on metal that has been annealed at too high a temperature or for too long a time, resulting in excessive grain growth.

Ordering

A change taking place in the solid state of certain alloys (e.g. 75%Gold/25%Copper) in which the normal random arrangement of two different types of atoms within the crystal lattice is transformed into a regular ordered three dimensional array of one metal in the other. The basis of the heat treatment hardening process in high Copper contented Gold alloys.

Oxidation

A chemical combination of Oxygen with a metal, forming an oxide, usually as a surface scale. Becomes more prevalent at elevated temperatures and may affect the structural integrity of an alloy, causing cracking when fabricated. Firescale in Sterling Silver is due to internal oxidation of the Copper within the alloy.

Pattern

A master or a consumable (lost wax process) model of a component to be reproduced by casting. Pattern dimensions may need to allow for net shrinkage or expansion over the whole casting process.

Pavé

A setting technique whereby a surface is “paved” with small stones in rows or clusters. Firstly seats must be cut to accommodate the stones which are then held in place by beads and then bright cut to highlight the effect.

Pickling
The process of dissolving away surface oxides and flux from metal after casting, working or more usually soldering, by immersion in a dilute acid or pickle bath. The solution is known as the pickle bath or pickle solution.

Pin Point Setting
Pin Point setting is usually done in a pre made plate or casting that consists of three or four small evenly spaced claws that are of the correct height and diameter for the stone to be set. The stone is then placed on the pre designed bearing and the act of setting is simple to push over the small claws to secure the stone. Because the preparation is so complete, this form of setting is very fast and highly suited to volume produced jewellery.

Planishing
Smoothing by overlapping light blows between a polished anvil and a polished hammer face. The piece is gradually rotated between blows that cold work the surface rather than in depth. Planish marks may be left in for decoration.

Plastic Deformation
Permanent deformation of a metal or alloy that remains after removing an applied force that exceeds the elastic limit of the metal. Below this limit, metal is distorted elastically and removing the force results in it returning to its original shape.

Plumb Solders
Carat solders are generally made to two possible standards. Firstly a solder may be described as "Solder for 18ct yellow Gold" this description states the solder is "for" use with 18ct and does not necessarily mean it contains 750 parts per 1000 of Fine Gold. Secondly it may be described as "18ct yellow Gold solder" in this example the solder description is stating the Gold content is 750 parts per 1000 Fine Gold. The second example is also describing what is known as "plumb solder" i.e. it has a stated level of Fine Gold and it meets the industry's fineness standards.

Polishing
Usually after grinding, the final finishing stage whereby a high lustre is imparted to metal using rotating wheels or brushes loaded with rouge or other polishing compounds. Can also be done in machines such as a tumbler, vibrator, rotating disc (or turbo) machine.

Porosity
Small voids within the cast metal piece often exposed during polishing. Created by either metal shrinkage or gas evolution on solidification. Oxidation of metals in the molten state may also lead to cavities forming in the metal as it solidifies. Silver alloys and non casting Gold alloys are particularly susceptible to these problems.

Pressing
Using a fly press or mechanical press to produce a batch of similar components. May involve stretch-forming, deep-drawing, coining, blanking, stamping, or bending. For Gold, it is a cold working operation.

Primary Gold
Mined Gold that may be smelted into a bullion bar. It is the first recovered Gold from its native source.

Protective Atmosphere
A gas atmosphere used in a furnace during heat treatment, annealing, soldering or melting operations to prevent oxidation of the base metal constituents in the carat Gold alloy.

Pumice
Spongy, volcanic rock used as a powder mixed with vegetable oil and applied to a felt bob or in its original form to remove scratches and file marks.

Quenching
Rapid cooling of hot metal in a fluid, which can be a cool air blast but is more likely to be water for Gold alloys.

Reducing Flame
A melting, annealing, soldering or welding torch flame with more gas than can combine with the injected Oxygen or air to give full combustion. It inhibits oxidation of the metal. Pure Gold does not oxidise, even with excess Oxygen, but most alloying constituents of carat Gold alloys do.

Refractory
High melting point ceramic materials used for furnace linings, crucibles and moulds. Often needs a suitable binder to hold the refractory particles together. Thermal shock resistance, chemical stability, acidity, surface finish (for moulds) are also important features of these materials.

Repousse
Technique for producing an ornamental surface by hammering into relief from the reverse side while using a firm but yielding support. Smaller scale and more detailed than embossing. Often used with chasing.

Retarder
Organic chemical additive to gypsum based investment, used to retard or control the setting process. This has the advantage of providing longer working times and improved de-airing of the slurry.

Rim Setting
In Rim setting the stone is first placed on a precut bearing and secured in place by pressing a rim of metal around the stones circumference just above the stones girdle. The pressing is done by a type of polished hollow punch whose dimensions closely match those of the stone and by applying precise alignment and pressure. The finished effect is very similar to Rubbed in setting, Hammer and Gypsy setting.

Rolling
Common cold working process for jewellery alloys to reduce cross section. Uses plain faced polished rollers for sheet and strip, grooved rollers for bar, rod and simple sections, pattern rolls for continuous embossing.

Rouge
Various Iron oxide powders bound with waxes or soaps into a paste or bar for polishing. Colour indicates type of oxide and degree of cut.

Rubbed In Setting
In this type of setting the stone is secured by a type of bezel which is more or less created by the setter, who, after seating the stone taps the surrounding metal into place and forms a rim of metal around the edge of the stone. The final finish is achieved by burnishing or bright cutting. The table of the stone will either be flush with the metal surface or slightly recessed. Rubbed in setting is also known as Hammer Set and Gypsy Set.

Ruby Powder
Polishing powder, more likely to be finely ground haematite (Iron oxide) than Corundum (Alumina, Ruby).

Scorper
A short cutting tool with a chisel face, for cutting narrow channels in metal. Usually broader than a graver.

Scrap

Rejects or excess metal by-product of casting, working and fabrication that can be recycled or reclaimed by refining. Usually more descriptive terms referring to the major precious metal constituent are used to describe the type of scrap e.g. Gold lemel and scrap, Platinum scrap, Silver scrap.

Semi Fabricated Materials

Stock sizes of a range of basic shapes e.g. sheet, strip, bar, wire, chenier, blanks etc, and possibly of different tempers (hardnesses) useful for further hand or machine working. Stock Gauge and Standard Gauge are terms used to describe specific semi fabricated products in sheet or rolled square bar forms.

Setting

Both the metal component that holds a gemstone and the act of securing the stone in such a component.

Silica

Silicon dioxide, an extremely common constituent of the earth's crust, selectively processed to form refractory and abrasive materials. Exists in various crystalline forms as Quartz, Tridymite or Crystobalite.

Sinking

Type of tube-drawing where the wall is allowed to find its own thickness (unlike mandrel drawing). Usually, the actual wall thickness increases.

Sink Hole

Depressions formed in the exposed face of metallic ingots caused by differential cooling and the consequent uneven shrinkage of the molten metal mass.

Soldering

Soldering is the process of joining metals through the use of heat and a filler metal (solder) the melting point of which is below the melting point of the metals being joined. In soldering, heat is applied broadly to the area of the joint. The solder is then brought into contact with the heated parts, it then melts instantly and is drawn by capillary action through the clearance of the joint, resulting in a strong and permanent bond between the two metals. In jewellery making the term soldering is actually hard soldering or brazing as it takes place at temperatures above 450°C.

Solder Flow

The term "solder flow" is a general term and usually describes how well a solder performs its intended function. It is fair to say that all Gold and Silver solders purchased from established precious metal dealers will perform at a satisfactory level. However a number of circumstances such as the following will effect how well a solder performs or flows:

- **The solder will not flow properly**

  The surface of the metal is not clean enough and still has oxides, grease, oil, dirt etc on the surface. Not enough heat has been applied to the metal. The heat has been supplied to the wrong general area of the solder joint. Too much flux has been applied to the joint.

- **The solder forms beads**

  Not enough solder has been used for the area to be soldered. The area around the solder joint has not been heated correctly and could be considerably higher or lower than the recommended soldering temperature range.

- **The solder runs away from the joint**

  The area to be soldered has not been cleaned properly. Insufficient flux has been applied or the flux is in the wrong area and drawing the solder away from the solder joint. Uneven heat or the area to be soldered is at a lower temperature than the surrounding area.

- **Pitting in the solder joint**
  The solder and or the metal have not been correctly cleaned. Excessive heat has been applied. The solder has broken down due to faulty alloying or incorrect manufacturing procedure.
- **Gaps in the solder joint**
  The solder and or the metal have not been correctly cleaned. Insufficient solder for the size of the joint. The piece being soldered did not have the correct joint clearance; the clearance can vary but is usually between 0.02mm and 0.15mm

Solder Paste
A homogenised mixture of carated Gold and Silver in the form of very fine powder combined with a liquid binding agent and flux. A syringe applicator is used to dispense the paste which allows for very accurate solder placement and controlled amounts.

Solidus
Refers to a line on a constitutional (phase) diagram of an alloy describing the temperature as a function of composition of an alloy below which the alloy is completely solid.

Spinning
A process of forming sheet metal into a domed shape by pushing a smooth tool against the spinning sheet to force it onto the former or the shape required. Can thin or thicken the resulting wall. This process requires both malleability and ductility, so most Gold alloys respond well.

Springiness
The ability of cold worked alloys to be deformed and to return or spring back to their original shape with little loss of energy.

Sprue
Wax section that joins the patterns to be cast to the pouring and feeder system. The central sprue (feeder) forms the main channel down which molten metal is poured to feed the casting cavities. The feeder sprues are the short sections from the central sprue to the gates and casting cavities the latter should be kept as short as possible to prevent the metal from freezing prematurely.

Stake
Steel former, usually with a smooth curved surface, used for raising metal from sheet to a deeper vessel form.

Stone in Place
A relatively recent form of setting that is used in conjunction with the lost wax process. The aim is to cast the stone or stones directly into the piece of jewellery by firstly setting the stones into the wax or into the rubber mould where in turn they will be set in the wax when the mould is being wax injected. During the burnout cycle the wax is lost leaving the stones held in place by the investment. Molten metal now fills the voids left by the wax and secures the stones in place. This method is also called Cast in Place.

Stress Relieve
Low temperature heat treatment. Involves no recrystallisation or phase changes, little change in hardness, slight increase in ductility, but reduces distortion and cracking in assembly. Also reduces the risk of stress corrosion cracking in low carat Gold alloys.

Superheat
An extra margin of temperature above the melting point of a metal or liquidus of an alloy to impart fluidity during casting and allow the molten metal to fill the mould without premature solidification.

Swaging

A hammering process to reduce or change cross-section of rod or tube. Swaging is done on steel blocks into which D-section grooves of various widths and depths are cut. Used for hammering strip into a sharp gutter shape when beginning to make a tube or for adjusting bar or rod sections.

Swarf

Metallic turnings, millings, drillings, etc. from machining operations.

Sweat Soldering

The Goldsmith's equivalent of the plumber's 'tinning'. A two stage soldering technique whereby one of the two components is coated with flux and then solder is flowed onto the surface. When cold, the two components are brought together precisely and reheated. Solder from the first component flows onto the second, joining them together.

Tarnish

A surface discolouration or blackening on Silver and carat Gold jewellery caused by corrosion in sulphur-containing environments such as exposure to atmospheric pollution or packaging materials. In Gold alloys, it is usually confined to certain compositions of 14 carat or lower.

Tensile Strength

Is relative to tension, that is the capacity of, say wire, to be drawn out or stretched. The tensile strength of the wire is the measurement of the maximum load (tension) that can be applied before breaking. The results of such testing could assist in the selection of the best alloy to be used in the manufacture of chain and findings.

Tension Set

In tension setting the stone is held in place at its girdle by the pressure being applied from two opposing sides of the stone. The side pressure is coming directly from the tension or spring of the ring shank. The stone is given additional security by seating the girdle of the stone into recesses that have been precut into the sides of the opening in the ring shank.

Thermal Diffusivity

The ratio of thermal conductivity to heat capacity (density x specific heat). A measure of chilling or insulation power. Of precious metals, Silver has the highest, Gold and high carat Gold alloys are almost as high but Platinum has low thermal diffusivity. A property that influences soldering and welding processes and the heat input required.

Tree

Assembly of wax replicas of an original master pattern, joined by wax feeder sprues to a central sprue. This creates a network of channels that act as the feeder system to a multiple number of products. The final assembly has the appearance, when inverted, of a tree.

Tripoli

Jewellery polishing compound made of very fine diatomaceous silica suspended in a waxy medium and loaded onto the face of a polishing wheel for medium and fine polishing stages.

Tumbling

Mechanised grinding or polishing process used to finish many pieces of jewellery in one batch. Items are placed in a barrel with abrasive ceramic chips, burnishing steel shot, polishing balls, nuts or stars and tumbled with successively finer media until a fine polish is achieved.

Ultra-Violet Radiation

Radiation of shorter wavelength than visible violet (say less than 400nm) but capable of affecting the retina of the eye without being perceived as colour. Less easily reflected than infra-red.

Water of Crystallisation

Water in chemical combination with a crystal, necessary for the maintenance of crystalline properties but capable of being removed by sufficient heat.

Wax Models

Wax replicas of a master pattern (made by injecting wax into rubber moulds cured around the master pattern) assembled into groups on sprues and then melted out of an investment mould to leave precise cavities which in turn receives the molten metal in the lost wax casting process.

Welding

Joining process which involves local melting of the component surfaces, often with addition of a similar filler metal. Thus, it differs from soldering. The parts are joined by mutual fusion, with or without flux, using a gas torch, electric arc or laser or by hot solid-to-solid pressure or hammer welding.

Wet & Dry Paper

Waterproof grinding paper coated with carefully graded and oriented Silicon Carbide particles (Carborundum). Used between filing and polishing stages.

Wettability

Ease of wetting between a fluid, (molten solder) and a solid piece of metal. Solders or weld fillers more or less wet the joint surface according to the liquid/solid contact angle (must be less than 90°) Mutual solubility lowers the angle as does flux by removing insoluble surface oxide.

Wheatsheaf Ring Sizes

A standard ring size system developed in the UK during the 1920's and is now recognised as the UK standard. It is also the accepted standard for ring sizing in Australia. The system is scaled against the alphabet A to Z+ with half finger sizes communicated as e.g. N$^1/_2$ or N+. Mathematically the inside diameter increases for each full finger size at a linear rate of approximately 0.40mm.

White Radiation

Mixed wavelength radiation in the visible light range of the spectrum (400nm to 750nm) but may include certain wavelength peaks (colour bands) and also associated infra-red and ultra-violet radiations.

Work Hardening

The work hardening of a metal or alloy will see an increase in its hardness and mechanical strength due to plastic deformation. This hardening is a result of the metal or alloy being subjected to cold working such as rolling, drawing, hammering and peening. A metals susceptibility to work hardening can be measured by performing a hardness test before and after a measured amount of cold working. Annealing, which results in a recrystallisation of the grain structure, is usually recommended after the metal or alloy has been cold worked and reduced in section by 60% to 65%.

Wrought Semi-Finished

Products intermediate between cast ingot and finished components stocked in useful or standard sizes, typically: sheet, coiled strip, bar, chenier and wire etc; usually annealed but may also be half hard.

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PETER W BECK

Peter W Beck Pty Ltd
Head Office
14 Duncan Court, Ottoway Park,
South Australia 5013, Australia
Toll Free (within Australia) 1800 888 528
Telephone 08 8447 1133
Facsimile 08 8447 1144
International Telephone +61 8 8447 1133
International Facsimile +61 8 8447 1144
Email contactus@pwbeck.com.au

Peter W Beck Precious Metal Services®
Toll Free (within Australia) 1800 888 590
Telephone 08 8440 3399
Facsimile 08 8447 1144
Email preciousmetals@pwbeck.com.au