THE GOLDSMITHS' COMPANY

TECHNICAL BULLETIN

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THE GOLDSMITHS' COMPANY

WELCOME...

to the first edition of the Goldsmiths' Company Technical Bulletin.This is the latest addition to the Company's expanding programme of activities in support of our craft and industry. It will be a vehicle for us to keep you abreast of new developments and to pass on technical information that we think will be useful. We hope you will find it interesting and informative. Our objective is to publish a bulletin twice a year. Any comments and suggestions that you have, to make the bulletin more relevant to your needs, are most welcome.

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Image on front cover courtesy of Weston Beamor

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INVESTING IN TECHNOLOGY:

WESTON BEAMOR - A CASE STUDY

I first visited Weston Beamor 10 years ago, not long after it moved to its current premises in Vyse Street, in the heart Birmingham's Jewellery Quarter, and have visited several times since. Each time, I have seen continuing investment in technology, not only in terms of equipment but also people and best practice.

Weston Beamor is a company with a very positive attitude to utilising technology to enable the business to flourish. And flourish it has over a period of 16 years, with turnover growing fourfold. Twenty-five years ago, it had a staff of 11 and a turnover of £150,000. Today, it employs 105 and turnover is around £11m and growing. Weston Beamor has been at the forefront in the United Kingdom in bringing platinum jewellery to market and, today, platinum represents a significant portion of its business. It does not compete in the low cost, volume end of the market, but rather in the quality, middle-top end with platinum and 18 carat gold as its focus and quality as its objective. Weston Beamor has an ethos of investing its profits back into the business and nowhere is this more evident than in its production technology.

"Why has Weston Beamor invested so heavily in technology and what benefits have accrued?", I asked Patrick Fuller, Vice-Chairman. In reply, he looked back at the beginning of his career in the jewellery industry: "The UK industry had been slow in investing in technology. It had bad working habits, inadequate working conditions and poor pay for skilled workers. It was still using the tools of its grandfathers!". He recognised the need for a culture change in the Weston Beamor business if it was to succeed and grow. Then, a lot of work was sub-contracted out to specialists.

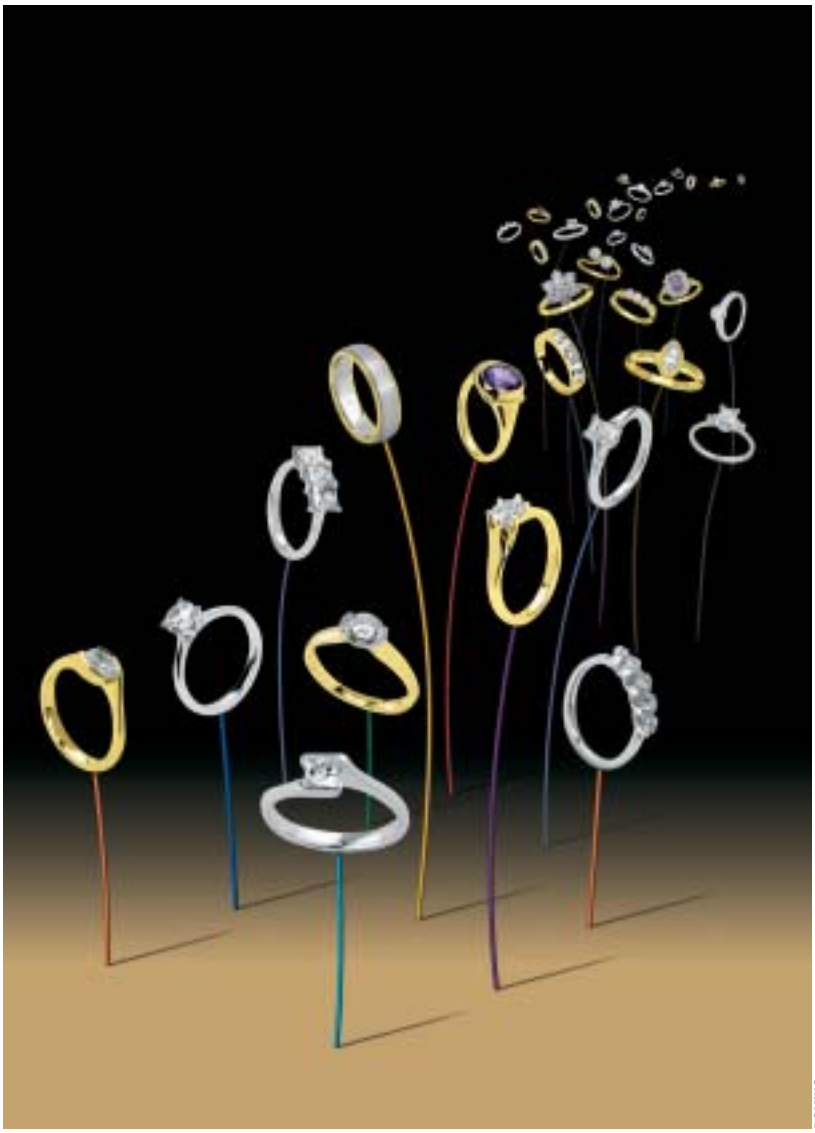
The core production technology is based around investment (lost wax) casting, support ed by mass finishing and stone setting, to provide both a quality service to industry customers as well as products to service its Domino jewellery business. More recently, this has been strengthened by laser welding, CAD and rapid prototyping (RP) technologies. Laser technology is focused on production of jewellery whilst the latter are important to product design and speed to market. The first technical move, about 15-16 years ago, was for Weston Beamor to employ its own model-makers and diamond mounters. This was followed by computerisation of its business. Later, major investment in production technology was implemented and this continues today in an evolutionary way. As the business has grown, space has been a constraint and forced a move to bigger premises twice in five years. The current premises were, and are, much larger than needed for the current business and give space to expand in the future. "It gave the opportunity to set out the factory in the way we wanted", explained Patrick, "and to be able to get large equipment into place without constraints of doorway size limitations, and so on, that we had in the older premises".

The company's philosophy has been to employ the best qualified people and to buy good quality equipment. To aid these decisions, Patrick has been fortunate to visit lots of factories around the world, including many members of Emagold in Italy. One US factory in particular, he admits, was an eye-opener for him. Despite this, Patrick says that they have made mistakes in buying the wrong equipment, bought for all the right reasons nevertheless. "A golden rule is always to see equipment operating in factories before buying", says Patrick. "A good machine manufacturer will be able to arrange this."

Currently, Weston Beamor has several good quality European-made centrifugal casting machines for platinum and three static, vacuum assist casters for gold and silver plus several burnout ovens in a spacious, clean and organised facility. A recent improvement has been to enclose the investment/flask preparation area into a separate, temperature-controlled room. "Already, Weston Beamor has seen quality and yield improvements as a result", claimed Chris Fenwick, Production Director.

The finishing equipment has also been upgraded with more advanced machines from Germany to replace the existing machines purchased a few years earlier.

Chris is an example of Weston Beamor's approach to investing in its people. He joined Weston Beamor in 2002 from the engineering industry, bringing experience and knowledge of new technologies and best practice now being embraced in the jewellery industry. His predecessor was recruited with top class jewellery industry experience from the USA and enabled Weston Beamor to upgrade its casting technology, which Chris is now developing. A good example here of Chris's input is Weston Beamor's investment in rapid prototyping equipment, a 3D Viper RP machine developed from engineering-oriented equipment used in the auto and aerospace industries. Chris had experience of using this in an engineering context and this has proved invaluable in training staff and putting the equipment into operation. Training of staff is a priority and much of this is now carried out in-house. This is supported by attendance at jewellery technology conferences in Europe and the USA and visits to important jewellery fairs, where there are strong equipment exhibitions such as Basel, Inhorgenta and Vicenza.



New Fundamentals catalogue launched in September 2004

WESTON BEAMOR

Close-up of casting process

Product design is central to the business and Weston Beamor employs its own design team, supported by CAD and RP technology. The latter investment is already paying its way and is increasingly popular with core customers. Currently, 80% of new models are made by CAD/RP. It is also offered as a service facility to the jewellery industry and is attracting new custom. CAD is used both as a product design tool and to design metal moulds for plastic pattern manufacture. "Plastic models give better surface finish and detail than waxes", says Chris. Metal mould technology is an old technology now reborn and finding a new role in jewellery manufacture.

Quality is emphasized as a major benefit of Weston Beamor's investment in technology. It is not just about expanding production and doing things more cost-effectively, important as they are. Quality is seen in several ways – better design, physical quality and improved consistency of production. Production is also more manageable despite the growth in production volume. The company's philosophy is to invest in technology only where it adds value. Patrick attributes the growth of the business to better (quality) products, which, in turn, is due to better equipment and practice.

Investing in technology has been, and continues to be, a significant reason for Weston Beamor's success. However, he also recognised early on that engendering the right attitude and approach by those employed by the business was also key to its growth. This is very evident at Weston Beamor. "Finding the best people, particularly those with the craft skills, is not easy in the UK industry," says Patrick. He would love to see an apprenticeship scheme locally in Birmingham, like the one in London run by the Goldsmiths' Company. In the absence of this, the company has been extremely active in undertaking in-house training and development of staff, leading to a skilled and adaptable workforce.

Weston Beamor has an open, positive attitude within the industry, which traditionally takes a very secretive approach to sharing knowledge. It has an 'open door policy' of allowing visits to the factory from those within the industry who come and see what it does and what it has achieved. It also supports students and works with several colleges to help with work experience, student projects and design competitions.

Weston Beamor has seen the benefit of this and employs several graduates as a result of this interaction. "Investing in the future is important for the industry", states Patrick. "Weston Beamor's, investment in technology has been very successful and will continue to underpin our competitiveness in the future."

www.westonbeamor.co.uk

CHRISTOPHER W. CORTI

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MANUFACTURING FOR PROFIT:

INVESTMENT CASTING TECHNOLOGIES

Investment casting is one of the major production methods employed within our industry. In this article we explore this process and review recent developments that are leading to improvements in the quality of the articles produced.

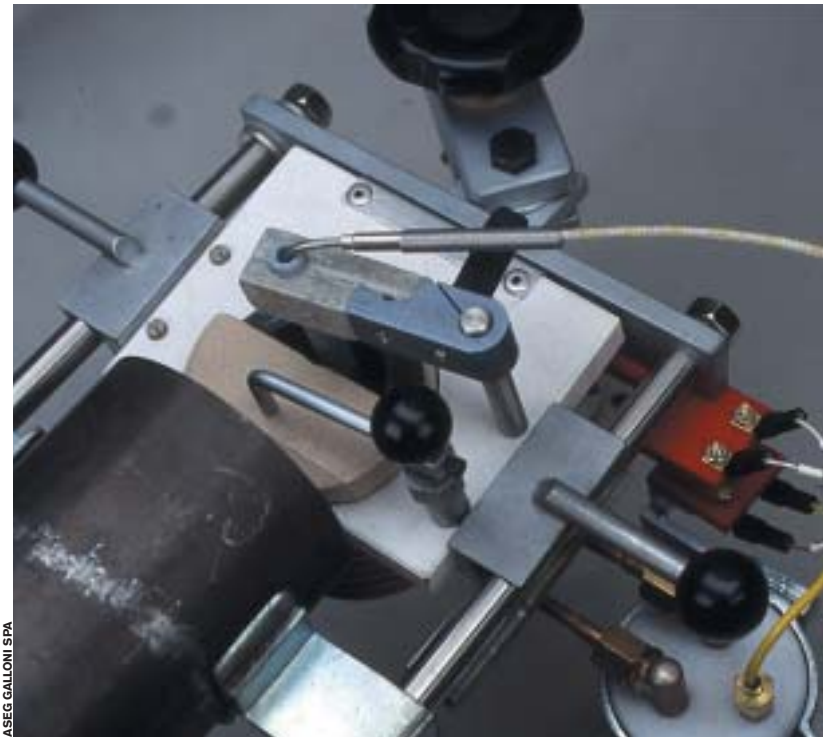
Introduction

Investment (or lost wax) casting of the precious metals is one of the earliest technologies developed by man and dates back over 4,500 years. It was practised by many civilisations, including those in Europe, the Middle East and South America.

It was 'rediscovered' for the jewellery industry only 50 years or so ago in the middle of the 20th century, when the dental industry casting technology was adapted to meet the needs of jewellery manufacture. To the modern caster, that technology may seem pretty crude, based on clockwork springs and melting with a gas torch in the open air. Not surprisingly, casting quality was hard to control.

Since then, the technology has made substantial strides and investment (or lost wax) casting is the major jewellery production technique worldwide.

Close-up of crucible and flask on Galloni broken arm centrifugal casting machine



ASEG GALLONI SPA

Why? Because it enables complex pieces of good quality to be made quickly and more cost-effectively than any other technology used in the industry today, whether it is used for 'one-offs' or mass manufacture. A key development was the invention in 1944 of flexible rubber moulds, which enabled the mass reproduction of intricate objects in the form of wax models from which castings could be produced.

The lost wax process is simple in concept but the practice is much more difficult, as any caster knows. The process is complex and castings are prone to various defects, leading to poor productivity, longer lead times and higher costs, none of which is good for a successful and profitable business. There is a tendency for casters to focus on the melting and casting stage, but defective or unsatisfactory castings are often attributable to one or more of the preceding stages of the process not being carried out correctly.

A Multi-Stage Process

Successful investment casting of jewellery in the precious metals – silver, carat gold or platinum – involves at least 13 separate stages from initial design to the finished article and failure to carry out each stage correctly will invariably lead to poor quality, defective castings. It also involves various consumable materials and several pieces of equipment as well as a choice of alloy formulations. Getting the right blend of materials, equipment and conditions is not an easy task.

The aim of this article is to shed some light on the casting process and, particularly, the options available to the caster. We shall also touch on the latest developments and where to find more information for those wanting to delve deeper into the technology and improve their productivity and casting quality. Future articles will focus on the other stages of the process that are important to the achievement of good castings.

Choosing the Right Process Technology

The starting point for any would-be caster should be to define requirements. This will determine what equipment should be purchased to meet those needs. For example, these include considerations such as:

- Whether casting one-off specials or large numbers in mass manufacture
- Whether casting silver, gold and/or platinum (and the mix ratio)
- Light or heavy castings or a range of weights
- Importance of fine details, surface quality, etc.
- Range of shapes and sizes to be cast
- Level and consistency of quality necessary
- Required output - *ie* number of flasks to be cast per day
- Plain castings or casting with stones *in situ*
- Work pattern - number of shifts per day, customer turnaround time, etc.

Choice of Casting Technology: Centrifugal versus Static, Vacuum Assist

The heart of the lost wax process is the investment casting stage itself. There are two basic options available: the (older) centrifugal technique or the newer static technique with vacuum assist. The former is cheaper in terms of capital investment, but is less able to deliver reliable and consistent quality or high production rates. For gold and silver, the static caster is now strongly preferred because of its higher level of process control. In many instances, the machines are fully automated and the opportunities for errors by the technician are considerably reduced.

In the case of platinum, however, the molten metal is less fluid and requires a stronger force that only centrifugal casting can give. There are static casting machines on the market with spinning flasks that claim to cast platinum but none satisfactorily fulfil the claims made for them, to my knowledge.

Comparison of Centrifugal and Static Casting

	Centrifugal	Static
Atmosphere control	Seldom (only in a few machines)	Normal (separate atmospheres in melt and flask chambers possible)
Metals	Gold, silver and platinum	Gold and silver only
Flask size	Small only (150mm/6in high)	Large (250mm/10in high)
Max. charge weight (gold)	800g/1.76lb	1.5kg/3.36lb or larger
Turbulence during pouring	High	Low (with correct feed system)
Risk of mould erosion and damage by melt	High	Low
Feed (sprue) system	Not critical	Critical
Productivity	Low (8-10 casts per hour)	High (20 casts per hour)
Control system	Basic programming	Sophistcated including self-programming
Capital cost (basic)	Basic machine with torch	Basic resistance heated m/c - €4-8,000
Capital cost (medium)		Medium resistance heated m/c - €20,000
Capital cost (high)	More sophisticated with induction melting €10-40,000	Fully automated m/c - €60-70,000

Centrifugal Casting

In centrifugal casting, the molten metal is pushed into the mould cavity by the centrifugal force exerted by the spinning rotor on which the crucible and mould are mounted. The technique has two weak points: a higher level of turbulence when the molten metal is 'poured' into the mould and a higher liquid metal pressure. Turbulence during casting increases the risk of gas porosity in the castings due to trapped gas. Escape of gas is more difficult as perforated flasks are not used. High metal pressure facilitates form-filling and makes the feed system less critical, particularly with very thin patterns. However, the high pressure can lead to erosion and impact damage on the mould and results in poor quality castings. In some instances, the mould can collapse under the pressure.

The pressure on the molten metal in the mould is not constant over its length, being highest at the top of the tree and lowest at the sprue button. The patterns at the latter end of the tree can be incompletely filled, whereas those at the top end can show finning arising from mould cracking under the pressure. Many centrifugal machines do not have atmosphere control and temperature control may also be poor, particularly if measured by optical pyrometer. This makes defects such as porosity, inclusions, etc. more likely. Heating of the crucible is typically by induction heating. Flask size and charge weight are limited and lower than static machines.

Static Casting

In contrast, static machines rely on gravity pouring of molten metal into the mould, usually via a stoppered hole in the base of the melting crucible. Thus, heat loss is minimised and enables a lower degree of melt superheat. In addition, the pressure is more uniform over the length of the tree in static casting. With such machines, atmosphere control

in the crucible and (separate) flask chamber is normally available and temperature measurement is easier and more accurate. In addition, air or gas in the mould is usually removed by the assistance of vacuum in the flask chamber ('vacuum assist') and use of perforated flasks. Heating of the crucible is typically by induction although resistance heating is employed in some cheaper, smaller machines. In many machines, the casting pressure can be augmented by supplementary gas pressure over the casting sprue button ('pressure over vacuum'), triggered as the metal is poured, to ensure good mould filling.

In general, static machines give more control over casting quality and consistency, with many machines being fully automated. A major advantage of static machines is that flask size and charge weight can be larger and, taken together with faster cycle times, result in significantly higher productivity. The table gives the comparison between the two techniques.

There are many casting machine manufacturers, each with a range of models of varying sophistication and capacity. Some make small bench top models tailored to the needs of craft jewellers. Many have the option of an attachment to produce the casting alloy as 'grain', use of which aids speed of melting and homogeneity in the casting as well as recycling of clean scrap. As stated earlier, many machines have induction heating to speed melting of the charge. The better machines use medium to low frequency induction, which increases heating depth and, therefore speed, and improves melt stirring (which increases as frequency lowers) due to electromagnetic forces induced in the melt.

Trends in Casting Machine Technology

This is a large topic in itself and we can only briefly touch on some aspects here. In centrifugal casting, the use of a variable geometry or 'broken arm' rotor helps to improve the symmetry of flow of the molten metal into the mould - a problem with the fixed rotor which can lead to incomplete mould fill of some patterns on the tree. In addition, the better machines offer a closed chamber to enable atmosphere control, better heating and temperature measurement systems. Some also allow applied vacuum to the end of the mould to assist in gas removal. Improved computer assisted process control programmes that also enable casting parameters to be stored are also becoming more widely available. In static casting, vacuum assist and induction heating is common, but 'pressure over vacuum' casting systems are an increasingly preferred extra. In some cases, pouring is also done under gas pressure to facilitate better mould fill and surface detail. The better machines have low frequency induction heating and are increasingly fitted with computer control (or artificial intelligence) that enable the machines to be self-programming, eliminating operator error. The latest advance is in integrated systems that control metal flow into the mould to ensure better casting fill and quality.

Other Important Equipment

The choice of the ancillary equipment used in investment casting is also important in terms of process control and productivity. Such equipment includes vulcanising press, wax injector, investment mixer and burnout oven. Of these, perhaps the burnout oven, used to fire the investment mould prior to casting, is the most critical. The simple ovens may be cheaper, but will tend to suffer from poor, uneven temperature distribution, leading to weak moulds and defective castings. Preferably, the burnout oven is fan-assisted, with an inner metal lining, rotary hearth and good temperature control and distribution.

Further Sources of Information

A problem for many casters is in knowing where to find useful information on the process technology and best practice, including health and safety aspects. Probably the best up-to-date source is the *Handbook on Investment Casting,* written by Valerio Faccenda and published by the World Gold Council, London in 2003 (e-mail: industry@gold.org; website: www.gold.org). This is also useful in that it lists many of the major manufacturers and all the major published literature on investment casting of gold. Whilst focused on gold, it is applicable to silver, and to platinum to some extent. An essential companion to this is the *Handbook on Casting and Other Defects,* by Dieter Ott, also published by the World Gold Council. This truly is a 'bible' for casters. It explains all types of defects that can occur and how to overcome them. For platinum, Johnson Matthey (www.platinum.matthey.com) and Platinum Guild International (www.pgiglobal.com) can provide useful information and literature. Other helpful articles can be found in the technical magazines, particularly *Gold Technology* (see archive on website, www.gold.org in the jewellery technology section), the Santa Fe Symposium proceedings (www.santafesymposium.org) and *AJM* magazine (www.ajm-magazine.com).

CHRISTOPHER W. CORTI

Neutec static casting machine

NEW TECHNOLOGY FOCUS:

DEVELOPMENTS FOR THE SILVERSMITH

Advances in rapid prototyping and other manufacturing technologies in recent years have demonstrated how new technology can be used to address some of the challenges of the changing global market by our industry.

The advantages these offer the jewellery manufacturer are relatively well documented; however, there is little information available for those working on a larger scale. There are a number of emerging technologies that are promising exciting new opportunities and potential for silversmiths. Over the course of future bulletins, we will examine some of these processes in depth and try to assess their potential for the future. In this first article, we provide a basic introduction to some of them and an outline of their possible application.

BELOW
Close-up of electrode tips used for TIG welding

BOTTOM
Welding a silver fork using the TIG welding process

ROSALIND MILLER

ROSALIND MILLER

Tungsten Inert Gas (TIG) Welding

Tungsten Inert Gas (TIG) welding undoubtedly presents potential opportunities for silversmiths working in both a manufacturing and craft context. Basic equipment is both cheap and effective, negating the cost issues so often associated with the adoption of new technologies and processes. By adopting a welding process utilising a filler wire of sterling silver rather than solder, problems associated with traditional methods of construction can be reduced. Assembly and repair of large castings, complex constructions containing a number of joints in close proximity and pieces later intended for enamelling can all benefit from this method of construction.

The Goldsmiths' Company has recently produced a technical report on Tungsten Inert Gas Welding for Silversmiths. For information on this, please contact the Technology & Training Department - training@thegoldsmiths.co.uk or, alternatively, telephone 020 7606 7010.

Rapid Prototyping (RP)

Developed for the engineering industry, RP is increasingly being applied to the design and manufacture of precious metals primarily through the jewellery sector (see 'Investing in Technology' in this issue). In reality, however, their application to smaller scale objects has raised a number of issues for those utilising the technology. Surprisingly, most RP is better suited to the production of larger scale objects. RP can be broadly broken down into two types:

1. Subtractive – Material is removed either by direct machining *eg* Computer Numerical Control (CNC) milling or non-contact processes such as laser cutting. Although more commonly available, the scale of equipment required for producing silversmithing scale objects can be prohibitive and expensive, especially where complex 3D forms are required. However, these technologies offer an excellent route to producing 2 and 2.5 dimensional decorative surface patterns and relief as well as tooling for production.

2. Additive – Material is added in successive layers, building the model in paper, polymers, resin or metal powders. Common technologies include stereo-lithography, Layer Object Manufacturing (LOM), inkjet and bubble-jet based processes. Increasingly accessible and cost-effective, these technologies offer a number of interesting opportunities for silversmiths.

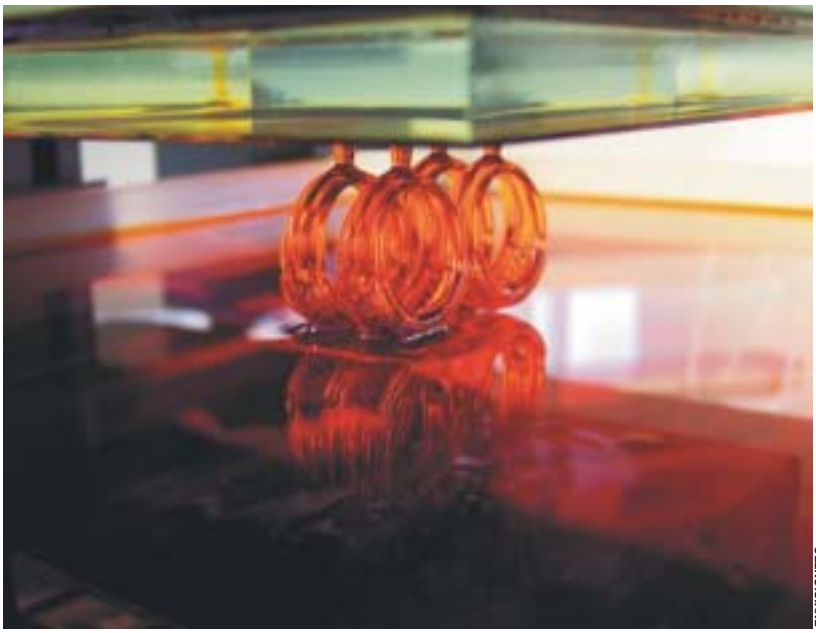
It is essential, however, that we recognise the difference between RP and Rapid Manufacturing. RP technologies were developed to provide prototypes and models, not finished items. However, with a little fettling, many of the outputs from these systems are now suitable for production purposes, *eg* produce silicon rubber moulds for casting purposes. They are also excellent for testing form, fit and function of objects prior to committing to a final design solution. To find out more about the RP process and the available technologies, the Goldsmiths' Company has produced a technical report on Rapid Prototyping Applications for the Jewellery & Silversmithing Industries. For information on this, please contact the Technology & Training Department - training@thegoldsmiths.co.uk or, alternatively, telephone 020 7606 7010.

Rapid Manufacturing (RM)

This term refers to the process of producing actual parts, either directly in metal (*eg* 3, 4 or 5 axis CNC milling, Selective Laser Sintering (SLS), etc.) where the Computer Aided Design (CAD) data drives production equipment thereby bypassing the prototype stage or, alternatively, as a result of utilising the output from the RP process such as a sacrificial pattern for production through conventional casting techniques. These are emerging processes within our industry and will be dealt with in more depth in later editions of this bulletin.

Laser Forming

Laser forming is an emerging rapid prototyping technique undergoing extensive research worldwide. The set-up is very similar to that of laser cutting: the process involves material being moved about underneath a CO_2 laser beam. However, when forming, the beam is defocused until it is some millimetres in diameter. As the laser locally heats the metal, it induces stresses within the material that cause it to bend. With the variables of laser power, traverse speed and beam diameter, it is possible to control the supply of energy to material and set up temperature gradients within the material during heating. To this end, the laser has the ability to bend metal in either direction without any contact with the part itself. It is also possible to increase the material's thickness at the point of heating, which results in a reduced surface area or shortening of the part. This mechanism is generally used to form bowls from sheet or to manipulate tubes. While the process may be in its infancy, laser forming can manipulate sheet, tube and spinnings into sophisticated parts suitable for designed objects.



ENVISIONTEC

If you would like to find out more about laser forming or see a demonstration, please contact: Dr. Sarah Silve at Brunel University:
sarah.silve@brunel.ac.uk.

Die-Less Numeric Control Sheet Metal Forming System: Next Factory

The die-less system by Next Factory in Italy represents the latest innovation in cold forming of sheet metal. This patented technology makes it possible to produce prototypes or small runs of steel, stainless steel and aluminium parts without the use of machines and traditional methods, including dies and die pressers. The system is completely automatic and run by powerful software and latest generation numeric control. Avoiding the use of conventional dies greatly reduces costs and production times and permits the production of complex parts in just a few minutes from three-dimensional CAD models. The tool carries out the sheet forming with concentric trajectories guided by 3-axis numeric control. Its rapid working speed means the forming process is completed in minutes. At this stage the process has not been applied within the silversmithing industry, although it undoubtedly has potential for application to larger scale objects, offering an alternative to hand raising, spinning, chasing and pressing.

For further information visit:
www.nextfactory.com

PETER TAYLOR

SARAH SILVE

TOP
Rapid prototyping machine from Envisiontec

ABOVE
Stainless steel convex and concave dish made using laser forming

MATERIALS MATTER:

CHOOSING THE CORRECT PLATINUM ALLOY

There has been an increasing interest in platinum jewellery in recent years. Sadly, there has also been an increasing number of consumer complaints. The most common of these is damage to rings in the form of dents and scratches occurring within a short time of purchase.

Assuming that the underlying cause is not a processing fault, such as casting porosity, one must look elsewhere for the reasons as to why some platinum items appear to have good wear and dent resistance whereas others can suffer damage. This article seeks to answer that question and to briefly discuss and explain the properties of platinum and its alloys.

Although there were a few isolated instances of platinum artefacts being made in earlier times, it was the Spanish conquest of Central and South America that revealed the existence of platinum to Europe and the rest of the world during the 17th Century. At first, it was thought that platinum was an impure form of silver and the Spanish called it 'platina' to distinguish it from 'plata', the Spanish word for silver.

Today, the major sources of platinum (Pt) are as sulphides, arsenides, antimonides and tellurides and as by-products from copper and nickel extraction processes. The sources are associated with the other platinum group metals (PGMs) and sometimes with gold and silver. The other PGMs are palladium (Pd), rhodium (Rh), iridium (Ir), ruthenium (Ru) and osmium (Os). These sources are to be found in South Africa at ~75% of the world's production, in Russia in the Urals and Siberia (~19%) and Canada (~6%). The extraction and separation of the various PGMs is lengthy and complex. World production of platinum in 2000 was 177 tons compared with ~2500 tons of gold.

Eternity ring in platinum by Sarah Jordan

JOHNSON MATTHEY

Properties

Platinum is very malleable, a property in common with other metals having a crystal lattice structure that is face centred cubic, e.g. gold (Au), silver (Ag), copper (Cu), lead (Pb) etc. Important physical properties compared to gold and silver are seen in the following table:

Metal	Density g/cm3	Melting point ^{o}C	Thermal Conductivity w/mK
Platinum	21.45	1769	73
Gold	19.32	1064	315
Silver	10.49	960	425

Density is weight per unit volume and platinum is one of the heaviest of all metals. Its high melting point means that special equipment and materials have to be used for melting and casting. The low thermal conductivity, or more specifically, the low thermal diffusivity (which is conductivity/specific heat x density), results in more localised heating, compared with gold or silver, when using a torch for annealing and soldering or laser welding operations. This means that less heating is required to achieve the required temperature, as less is lost by conduction away from where it is needed. The melting, casting and working processes used for platinum and its alloys will be discussed in a separate article in a future Technical Bulletin.

Its reflectivity over the visible light spectrum ranges from about 48% at the violet end to 70% at the red end and so it is seen essentially as a 'white metal'. This compares with 72-80% for rhodium and 82-97% for silver, the most brilliantly white of all metals.

Thus, platinum is less bright in appearance than other white precious metals.

Platinum does not react with air or oxygen, i.e. it will not oxidise when heated, but it will begin to evaporate at temperatures >1000°C. It is insoluble in most acids but will dissolve in aqua regia, a mixture of 3 parts of concentrated hydrochloric acid (HCl) to 1 part of concentrated nitric acid (HNO3). It has excellent corrosion resistance.

The mechanical properties of platinum include strength, ductility (a measure of malleability), hardness and toughness. Some of these properties are given for both the annealed and the work hardened conditions in the table opposite.

It can be seen that platinum has a higher rate of work hardening than gold and silver. The higher modulus of elasticity means that, from a practical viewpoint, there will be less elastic spring back when working the metal, advantageous in gem setting, for example.

However, the relatively low hardness and strength of platinum does show that, in common with fine gold and silver, it has to be strengthened by alloying before it will be suitable for service as precious metal jewellery. This brings us to the main aim of this article. Why are some alloys more suitable than others for certain items, *eg* rings?

Metal	Condition	Hardness HV	Tensile Strength N mm-2	Elongation %	Mod. of Elasticity N mm-2
Platinum	Annealed	37	124	45	17.2 x 104
	Hard	108	349	7.5	
Gold	Annealed	20	124	45	7.72 x 104
Silver	Annealed	26	138	50	8.06 x 104
	Hard	95	308	5	

Composition*	Solidus oC	Liquidus oC	Hardness HV	Elongn %	Applications
Pt-5% Cu	1725	1745	Ann. 120	29	General purpose
Pt-5% Co	1750	1765	Ann. 136 CW 200	20	Good casting alloy Can be worked
Pt-5% Ir	1780	1790	Ann. 80	30	High work hardenability for safety catches & pins
Pt-10%Ir	1780	1800	Ann. 110 CW205		Springs, watch CW backs, USA
Pt-5% Pd	1755	1765	Ann. 60	22	Castings, delicate settings
Pt-10%Pd	1740	1755	Ann. 60	22	General purpose in Japan
Pt-5% Ru	1780	1795	Ann. 120 CW 280	32	General purpose wrought alloy with good machining properties
Pt-4.8%HTA	1550	1650	See below for details.		

***Note:** Cu - copper, Co - cobalt, Ir - iridium, Pd - palladium, Ru - ruthenium, HTA - heat treatable alloy, Ann. - fully annealed, CW - cold worked

Alloying of Platinum

The hallmarking regulations vary throughout the world. Most of Europe, including the UK, has adopted a single 950 fineness Pt standard. For example, an alloy of 85% platinum and 10% palladium can be marked 850 Pt/100 Pd. In the USA, items must contain a minimum of 50% Pt and 95% minimum of PGMs. For example, one may see reference to '14K Platinum' which is 585 (58.5%) Pt and a further 365 minimum of another PGM, usually palladium or iridium. Japan accepts all levels from 85-100% Pt with a 90% Pt alloy being the most popular.

The table opposite contains data for the platinum alloys in common usage. It must be emphasised that suppliers do not always quote actual compositions for the alloys in their catalogues.

Although Pt-5% Cu and Pt-5% Ru are widely used for general purpose work because of their good workability and machinability, the Pt-Cu alloy is not usually recommended for castings as the surface finish is said to be poor. There have been conflicting reports regarding the suitability of Pt-Ru alloy for castings. The Pt-5% Co alloy has been widely used in Europe for the production of good castings and is gaining in popularity in the USA and Hong Kong. It has good fluidity and form filling characteristics, good hardness and strength. There is no surface oxidation of the castings although there is a very slight bluish tinge, thought by many to be a preferable colour to that of other Pt alloys. It displays a slight magnetism that can be a problem when separating scrap from iron filings. It polishes well. An alloy containing 4.8% Cu+Co has been developed recently that is said to combine the fluidity in casting with the enhancement of malleability due to adding Cu and it is non-magnetic. Pt-Pd alloys, popular in Japan and the Far East, are very soft and have a dull colour. For this reason, they are sometimes rhodium plated. Diamond machining of platinum is frequently used in jewellery manufacture and is quite different to

PLATINUM GUILD INTERNATIONAL

JOHNSON MATTHEY

TOP
Tack welding a platinum V prong onto a hand made setting
Courtesy of J. Maerz Platinum Guild International

BOTTOM
Ring damaged due to inappropriate use of Pt-5% Pd alloy

machining of gold and silver. It is worth noting that the various platinum alloys have different machining characteristics and this may influence choice of alloy.

Heat Treatable Alloys (HTA): These are various proprietary alloys containing proportions of indium (In), gallium (Ga), copper and/or other elements that can be considerably strengthened by heat treatment. To obtain the alloy in its softest annealed condition, it must be heated to around 1100°C and then water quenched. This is referred to as the 'solution treated' condition and the hardness is ~160-185HV, depending on the actual composition. Cold working (50%) increases the hardness to 340-360HV. Ageing at 700°C after solution treatment also gives a hardness of 340-360HV but ageing at the same temperature after 50% cold work increases the hardness to 420-430HV. The alloy is hard and springy, particularly in the aged condition, and is very suitable for the production of findings and other applications where springiness is required as well as those where enhanced strength is desired. However, it will be obvious that the solution and ageing treatments require a furnace in order to control quality and reproducibility of properties.

In summary, there is a range of alloys that can be selected for jewellery manufacture. Which alloy is used depends on both the production process to be used and the service conditions in use. It is the contention of this writer that 950 Pt-Pd and Pt-Ir alloys are not so suitable for those items of jewellery that are going to experience a lot of wear and knocking when worn by the consumer. Furthermore, rings cast in a Pt-5% Au (Au - gold) alloy have appeared on the market and these have been seen also to suffer badly from consumer damage. Again, this alloy only has a hardness of ~90HV. Some of the rationale used by the manufacturers for casting rings in these alloys has been that there are no oxidation problems and that they produce good castings. However, this has been done at the expense of ignoring the stresses and strains experienced by the items when in service. Designers, manufacturers and even retailers do need to be aware of the influence of section dimensions and mechanical properties when producing items of precious metal jewellery. Where strength and springiness are important properties, the use of the heat treatable alloys may be preferred.

Further Information

Johnson Matthey plc and Platinum Guild International publish booklets on platinum alloys and their use in manufacturing. Further information is available on the following websites:
www.matthey.com
www.platinum.matthey.com
www.pgiusa.com

MARK GRIMWADE

Relevant Articles

1. ***The development of platinum alloys to overcome production problems,*** **J. Huckle, Proc. Santa Fe Symposium, 1996, p301–326**
2. ***Manufacture of lightweight platinum jewelry and findings,*** **D.P. Agarwal & G. Raykhtsaum, Proc. Santa Fe Symposium, 1996, p373–382**
3. ***Novel hard platinum alloys,*** **T. Biggs, L.R. Lomboard & N. Adams, Proc. Santa Fe Symposium, 1997, p133–142**
4. ***Platinum alloy applications for jewelry,*** **J. Maerz, Proc. Santa Fe Symposium, 1999, p55–72**
5. ***Understanding heat treatable platinum alloys,*** **G. Normandeau & D. Euno, Proc. Santa Fe Symposium, 1999, p73–104**
6. ***A study of machining parameters and their effect on the surface texture of platinum alloys for jewelry applications,*** **R.D. Lanam & C. Volpe, Proc. Santa Fe Symposium, 1999, p319–368**
7. ***Machining of platinum alloys for jewelry – Pt II,*** **C. Volpe & R.D. Lanam, Proc. Santa Fe Symposium, 2000, p361–374**
8. **Proceedings of the Santa Fe Symposia may be obtained from the publishers – see www.santafesymposium.org**

TECHNICAL SURGERY:

ASK THE EXPERTS

Do you have a manufacturing problem?
Are you having trouble finding a suitable alloy for a particular application, preventing porosity in your castings or adjusting the colour of your solder to match the item?

THE GOLDSMITHS' COMPANY

Well, this is your opportunity to ask the experts for advice on solving your particular problem. Not only will they tell you what to do, but they will explain the probable cause and why it occurs. Please email your problem to: **training@thegoldsmiths.co.uk**

Q. Why do my (investment) castings vary in weight? We control wax injection to give constant wax weights.

A. If your wax weights are constant, then the most likely cause is variations in shrinkage porosity in your castings. This suggests that the feed/sprue system needs optimising to give a better control of solidification; an insufficient metal charge (small sprue button) may contribute to this problem. Other possibilities include mould dilation or erosion due to weak moulds or gas release, which pushes the metal away from the mould wall.

Q. Is 9 carat gold harder than 18 carat gold jewellery?

A. This is not a straightforward question to answer. The answer could be yes or no! It all depends on the alloys used in the comparison. A red 18ct gold will be stronger than a pale yellow 9ct gold, for example, even though it contains fewer alloying metals. This is because copper (which is responsible for the red colour) is much more effective at hardening gold than silver or zinc (which lighten the colour of gold). Not only that, additional hardening mechanisms are at play in copper-containing alloys. So, to summarise, the answer is "not necessarily"!

Read the article on gold alloys on the World Gold Council website, in the jewellery technology section, www.gold.org/jewellery/technology, to see how varying the composition of carat gold alloys changes their hardness and other properties.

I am often asked a similar question relating to platinum and gold jewellery. Again, it depends on the alloy. Some platinum alloys are harder than others, as Mark Grimwade's article in this bulletin explains. Some carat golds are harder than some platinum alloys and vice versa. Hardness, of course, is roughly related to wear and scratch resistance. Studies have been conducted on the relative wear resistance of 9ct and 18ct golds but, again, it was found to depend on actual alloys. It is not possible or sensible, to generalise.

CHRISTOPHER W. CORTI

REPORT:

VICENZAORO 1 FAIR

16th–23rd January 2005

For the last three years, Oromacchine - the machine exhibition within the Vicenza Jewellery Fair – has been held in a separate building at both the January and June shows and features the machines and consumables of over 150 companies, not only Italian but many from Europe, Japan and the USA.

An additional advantage for potential customers is that they can visit the factories of the Italian exhibitors just a short distance away, if necessary. It has developed noticeably during this period and now offers the opportunity to view a wide range of appropriate technology for our industry. This year's event covered the spectrum of manufacturing technologies and materials for the modern producer.

I have taken the opportunity presented by this report to illustrate some of the key innovation and technology development areas on show.

Rapid prototyping, coupled with CAD, is having an impact on the industry, but the considerable capital cost of the equipment and consumable plastic material cost inhibits its wider use. The Next Factory has addressed this problem with the launch of a new RP machine, DigitalWax 010. Retailing at around €25,000, the machine can produce models of rings for around €0.20 each in terms of materials cost. The model accuracy is also good with a layer thickness down to 10 microns possible. Models are easy to polish too. The plastic resin for the RP models has a low ash content so it is good for direct casting. The model can also be used for rubber mould manufacture, using vulcanising temperatures of <70°C. The table dimensions are 200 x 200 x 60 mm high, making it practicable for most applications. This is a good value, quality machine that should find wide use in the industry. Accuracy has not been sacrificed, although speed of operation is lower than other, more expensive machines. This machine will herald widespread use in the industry, including the small producers.

NEXT FACTORY

The new DigitalWax 010 rapid prototyping machine

Polishing by machine is now the accepted technique for most jewellery producers. The magnetic polisher with steel needles for burnishing is widely used but often leaves an 'orange peel' surface; an alternative non-metallic medium has been developed by Metalfinishing Srl under the trade name Macrobrill, which claims to eliminate the orange peel, to be suitable for thin fragile pieces and does not lead to any oxidation problems found with stainless steel media. However, whatever polishing technology is used, recovery of the waste precious metal removed in the process is not always so easy. OTEC GmbH has now introduced their patented micro-filtration units which are coupled to the finishing machine. Described as less costly and user friendly, the MF series units clean the waste water from wet grinding/polishing machines in a closed loop circuit system and filter off particles larger than 0.2 microns.

This trend towards the improved recovery of precious metals from solutions was very evident with several companies displaying electrolytic precious metal recovery equipment, including one, the Bravor™ model by Gruppo De Nora. It selectively recovers gold and other precious metals from electroplating and wash solutions and rinse waters down to a few parts per million. Development also continues around electroplating systems. Bright rhodium plating baths were featured on several stands, including LegOr Srl, which claimed to be producing a bright, white finish. Clearly, this is a reflection of the increased interest in diamond and white gold jewellery. LegOr demonstrated that a flash palladium under-layer

further improved the colour of their new Ultrabright Rhodium W bath.

Investment (lost wax) casting continues to dominate jewellery production and there is a wide range of machines on the market. At Oromacchine, all the major producers - too numerous to mention - were exhibiting their latest machines. These included new centrifugal machines. Supercast with RCS, for casting platinum by Seit Electtronica Srl, features a coil that rotates with the arm and heating continues during initial rotation to ensure the melt does not cool as it is cast into the flask. Aseg Galloni Spa featured its Fusus centrifugal machine with inert gas protection as well as a new vacuum wax injector. Maxmatic of France displayed its award-winning range of wax injectors, judged by the experts to be the most advanced on the market. Neutec USA casting machines were also on display. The new Flowlogic technology is also judged by the experts to be the most advanced in the field.

Two UK-based manufacturers of investment casting powders were present at the Fair - SRS Ltd and Hoben International. The latter exhibited the new Gold Star Pt phosphoric acid-based investment for platinum investment casting. Opticom Sas exhibited its new platinum melting furnaces, in which the induction heating coil tips with the crucible to ensure that the melt does not cool at the crucible lip on pouring.

In terms of modern manufacturing technology, lasers are making a significant impact and many machines were on display, including the welder from Neutec USA, which, it is claimed, welds silver extremely well. Sisma Spa had a range of machines on show, including laser cutting of shapes from strip (similar to conventional stamping technology but without expensive tooling), welding and laser engraving. Alloy producers were also much in evidence with alloys tailored for particular applications. LegOr Srl introduced two new pre-alloys for white gold developed especially for 'stones-in-place' casting. Based on nickel and silver as the primary whiteners, they show good fluidity at low temperatures and have been developed for the Asian market for 10 and 14 carat white gold gemset jewellery, presumably for export to the West.

Returning to casting, there were several exhibitors of continuous casting equipment, including Indutherm GmbH and IECO Srl. The latter had its Fast Wire upcaster on display, producing small diameter silver tube with a good finish. Mould change is very rapid, without the need for cooling the system down.

This report can only give a quick impression of the machine hall and its exhibits. I do not have space to mention presses, stamping and hollow tube machines, wire drawing trains, CAD software, laser engraving and CAD milling machines, bench tools and much, much more that were on show. Vicenza is one of the top fairs for machines, alloys and other consumables and now rivals Basel in size and quality and I commend it to you.

CHRISTOPHER W. CORTI


NEUTEC/USA

ABOVE
Neutec/USA spot welder in operation


NEXT FACTORY

BELOW
Ring model produced on the new DigitalWax 010 rapid prototyping machine

THE LONDON ASSAY OFFICE:
HALLMARKING UPDATE

This section is prepared by the London Assay Office. It provides updates on technical issues that impact on hallmarking and information on recent changes to hallmarking regulations. It also outlines new services provided by the London Assay Office.

White Gold and Hallmarking

The colour of a gold alloy can be made whiter with the addition of whitening elements such as nickel, silver and palladium. The extent of the whitening depends on the relative quantities of these elements. In practice, the mix used depends on a number of issues. For example, nickel is an excellent whitener but has become less fashionable because the EU Directive on Nickel Release has made the trade cautious of its use. In addition, silver provides a cheaper alternative to palladium but is a less effective whitener.

RIGHT
Inscription on the plaque given to HRH The Prince of Wales

THE LONDON ASSAY OFFICE

BELOW
HRH The Prince of Wales inspects some hand marking on his visit to the London Assay Office

ADRIAN BROOKS

A consequence of the different alloying routes to achieve whitening is that white golds tend to exhibit a range of colours from perfectly white through steel-like grey to very pale yellow. The matter is complicated by the propensity for rhodium plating these alloys to enhance the whitening effect, creating a perfectly white colour. Indeed, an issue about which the London Assay Office frequently receives enquiries from the public is when the rhodium plating wears away, exposing a less white, often yellow substrate. Even though this substrate may be 'white gold' and technically white to the trade, the consumer clearly does not share the same opinion.

To address the different expectations of the trade and consumers, a White Gold Task Force has been set up by the Manufacturing Jewellery Society of America and World Gold Council.

The development work has resulted in a proposal to use colour measurement to grade white golds. Essentially, alloys which lie outside defined colour measurement ranges could not be described as white. Further details on the proposals, and the outcome of any agreements, are expected to be published in the next edition of this bulletin.

In terms of hallmarking, white golds do not provide any particular issues – essentially it is the quantity of gold present and not the colour that is important. As for any item submitted for hallmarking, a white gold article will be hallmarked

at the appropriate fineness determined by assaying a sample taken from the item. In addition, rhodium plating is permissible under the 1973 UK Hallmarking Act.

Laser Engraving Services

HRH The Prince of Wales visited the London Assay Office in early February. While the visit had been scheduled for some time, it was not expected that he would decide to announce his engagement to be married just before he arrived.

On hearing the news and to commemorate the announcement, the staff on the laser marking floor hurriedly re-engraved a new plaque to replace one it had already prepared for Prince Charles as a memento and to demonstrate its laser hallmarking and engraving services. The Prince seemed very impressed at the speed with which the plaque was produced.

The London Assay Office now offers a wide range of laser engraving services, such as marking of inscriptions, logos, signatures and simple or sequential lettering and numbering. The engraving can often be done at the same time as laser hallmarking, reducing the need for further handling. A fast turnaround is possible, as The Prince of Wales experienced.

European Hallmarks

The UK has been a signatory to the International Convention on Hallmarks since 1972. The Convention is an agreement between states. Convention Hallmarks have the same legal status as a UK hallmark. This means that articles bearing Convention Hallmarks do not have to be re-hallmarked in the UK. Those countries in the Convention are listed in Table 1. Latvia, Lithuania and Cyprus are recent additions.

In addition to Convention Hallmarks, a ruling by the European Court of Justice requires the UK to accept other national hallmarks provided the hallmarking is carried out in a similar way and that the hallmarks are equivalent and intelligible. Under the guidelines of the British Hallmarking Council, those national hallmarks deemed equivalent to UK hallmarks are listed in Table 2. It should be noted that changes to the French laws in 2004 mean that French hallmarks are no longer accepted in the UK.

For further details on any of the above, please contact: *The Deputy Warden of the London Assay Office* at: **admin@londonassayoffice.co.uk or telephone: 020 7606 8971**

DR ROBERT ORGAN,
Superintendent Assayer

COUNTRY	CONVENTION (CCM)	NATIONAL HALLMARK
Austria	YES	No
Cyprus	YES	YES
Czech Republic	YES	No
Denmark	YES	YES
Estonia	No	YES
Finland	YES	YES
France	No	No
Hungary	SOON	No
Ireland	YES	YES
Netherlands	YES	YES
Norway	YES	No
Malta	No	No
Poland	SOON	No
Portugal	YES	YES
Slovakia	SOON	No
Slovenia	No	No
Spain	No	YES (A1, V1, M1)
Sweden	YES	No
Switzerland	YES	YES
United Kingdom	YES	YES

LEFT
Table1.
List of countries who apply Convention Marks

BELOW
Table 2.
National hallmarks deemed equivalent to UK hallmarks (as of 1st March 2005)

SPONSOR'S OR MAKER'S MARK	COMMON CONTROL MARK			FINENESS (PURITY) MARK*			ASSAY OFFICE MARK
	Gold	Silver	Platinum	Gold	Silver	Platinum	
A B	375	800	850	375	800	850	Austria, Czech Republic, Denmark
	585	925	900	585	925	900	Finland, Ireland, Netherlands, Norway
	750	999	950	750	999	950	Portugal, Sweden, Switzerland
	916		999	916		999	
	990			990			
	999			999			London, Birmingham, Sheffield, Edinburgh — United Kingdom

SOURCES OF INFORMATION:

THE GOLDSMITHS' COMPANY'S TECHNOLOGY PORTAL

Have you ever wanted to source a casting or polishing machine, or an alloy supplier, but not known who to contact?

The Goldsmiths' Company Technology Portal

Have you ever needed to find a caster or electroplater? Have you ever known the name of a company but not their telephone number or location? Have you ever wanted to find the website of the World Gold Council, DeBeers or the British Jewellers Association? Just where do you find such information readily? Well, your problem is now solved. It is all at your fingertips.

The Technology Portal, within the Goldsmiths' Company website, www.thegoldsmiths.co.uk/technology&training/techportal, was launched at IJL London in September 2004. A searchable database of over 340 suppliers and manufacturers of machines, consumable materials and services in the jewellery and silversmithing industries, it is a unique source of information on 'who does what' for the UK industry. It includes companies from the UK, Europe, USA and Japan and provides direct links to each company's website. The Technology Portal is very easy to use, even if you are not a computer expert. Simply open up the website, type in 'key words' then click on the search button. A list of companies will be presented. Click on the company link to view full details, including address and types of product and services offered. Click on the website address for the company to visit the company's own website. It couldn't be easier. Alternatively, you can search by category – trade associations, training and education, manufacturers of casting machines, service providers, electroplaters etc.

For anyone working in the industry, whether at the craft end or mass manufacturing, the Technology Portal will prove to be an invaluable resource. The full list of the Goldsmiths' Company Technical Reports can also be viewed on the Technology Portal and electronic copies of each are available on request.

We will be reviewing useful websites and other sources of information as a regular item in future bulletins. If you have a suggestion for inclusion, please e-mail: **training@thegoldsmiths.co.uk** or post to: **The Technology & Training Department, The Goldsmiths' Company, Foster Lane, London EC2V 6BN.**

INDUSTRY

TRAINING OPPORTUNITIES

There is now a wide range of high quality training opportunities available to the industry some of which we illustrate below.

School of Jewellery, Birmingham

The 2005 School of Jewellery Short Course programme includes a wide range of courses to inspire and encourage the development of practical and technical jewellery skills for the beginner or crafts person. The programme runs from March to July, and the School has once again sourced tutors of international or national repute.

Among the courses on offer are several 3-dimensional CAD courses which cover a variety of software programmes, jewellery making courses from beginner level to fine jewellery to master classes in mokume gane, enamelling, silversmithing, platinum, creative laser welding, granulation, hydraulic die-forming and, new for 2005, mould making. Last year's popular 6.5 day practical diamond grading course will be repeated in July, as will a range of courses on stone setting, gemmology and watch repair at various levels.

For further information or a brochure,
telephone or fax: 0121 248 4582
or email: **dawn.meaden-johnson@uce.ac.co.uk**

London Metropolitan University

The Cass offers a comprehensive short course programme in silversmithing and jewellery, with the summer programme taking place from 4th-22nd July. This year there are around forty courses which fall broadly into three types. These are, firstly, basic making skills including areas such as stone setting, practical jewellery, silversmithing, chasing, hydraulic press forming, casting and polishing. The second type consists of more exotic techniques such as working with stone, mokume gane, granulation, various enamelling approaches and anti-clastic raising. Also offered is a range of introductory courses aimed at new or aspiring makers and well established Rhino 3D computer courses.

To request a short course brochure,
telephone Alan Craxford on 020 7320 1926
or email: **a.craxford@londonmet.ac.uk**
or visit: **www.londonmet.ac.uk.**

Holts Jewellery School, London

In addition to its existing tailored training courses, Holts is offering a five-day programme on Computer Aided Design and Manufacture in which students will receive IT training tailored for the jewellery industry. Students will learn how to model and render jewellery designs in 3D and will have the chance to export their own models to a rapid prototyping machine.

For further information on new and existing courses, please contact:
Claire Black on 020 7405 0197
or email: **school@rholt.co.uk**
or visit: **www.rholt.co.uk.**

We would be happy to mention any other training opportunities in future issues. Please send to the editor at: training@thegoldsmiths.co.uk

CALENDAR OF EVENTS

SEPTEMBER 2005

1st-3rd September
Japan Jewellery Fair
Tokyo, Japan
www.jja.ne.jp

3rd-5th September
JAA Australian Jewellery Fair
Sydney, Australia
www.jewelleryfair.com.au

4th-7th September
International Jewellery London, Earls Court
For the second year running the Goldsmiths' Company will be taking a stand at the annual IJL Exhibition. The Technology & Training team will be on hand to answer questions about the products and services offered by the department and will be joined on their stand by Chris Corti and Mark Grimwade who will be available to answer any technical or metallurgical questions from fellow exhibitors and visitors to the event. Stand No. 422.
www.jewellerylondon.com

4th-7th September
Autumn Fair, NEC Birmingham
www.autumnfair.com

7th-11th September
Hong Kong Watch & Jewellery Fair 2005
www.hkwatchfair.com

10th-15th September
Orogemma
Vicenza, Italy
www.orogemma.vicenzafiera.it

OCTOBER 2005

4th-6th October
Time Compression Technologies
NEC, Birmingham. The largest rapid product development conference and exhibition in Europe.
www.time-compression.com

3rd-9th October
Goldsmiths' Fair 2005
The annual leading selling exhibition of distinctive and unique gold, silver and gem-set jewellery and innovative and original silver for today's interiors made by the brightest contemporary jewellery and silver designer-makers, now in its 23rd consecutive year.
www.thegoldsmiths.co.uk

DECEMBER 2005

5th-9th December
International Jewellery, Dubai
www.jewelleryshow.com

JANUARY 2006

15th-22nd January
VicenzaOro1
Vicenza, Italy
(includes Oromacchine machine exhibition).
www.vicenzaoro1.it

16th-20th January
Getting Started
An Introduction to Business for Jewellers & Silversmiths.
A week-long course for recent UK graduates of precious metal courses. Delivered as a series of seminars and workshops, this annual programme focuses on the 'next' steps for those wishing to pursue a career within the industry.
www.thegoldsmiths.co.uk/technologyandtraining/

FEBRUARY 2006

5th-9th February
Spring Fair Birmingham
NEC, Birmingham
www.springfair.com

An up-to-date list of events and exhibitions hosted by the Goldsmiths' Company can be found on the website under the 'What's On' section.