Conference report

The 23rd Santa Fe Symposium on Jewelry Manufacturing Technology, 17-20 May 2009 in Albuquerque, NM, USA

The 23rd annual Santa Fe Symposium on Jewelry Manufacturing Technology was held in Albuquerque, New Mexico, USA from 17-20 May 2009. Once again, the organisers had put together a strong, attractive programme covering all areas of interest. Attendance was down on previous years, reflecting the impact of the current recession in the jewellery industry in the USA, although, surprisingly, representation from Europe was strong.

The Symposium commenced with Chris Corti (CoreGold, UK) giving the 3rd in his 'Basic Metallurgy' series on "Cracks, Defects and their Prevention". This examined the causes of cracking and other defects commonly found in manufacturing jewellery. These included embrittlement by impurities and minor alloying additions such as silicon, which can manifest itself as hot tearing and quench cracking in casting; such embrittlement can occur in all 4 precious metals. Other causes include cracking due to shrinkage porosity, inclusions and pipes from casting and fire cracking from annealing practice. Stress corrosion cracking can occur after manufacture, when the jewellery is in service. They all appear similar in character, but the causes are quite different.

Gold

In these days of high precious metal costs, it is useful if one can use less metal in jewellery manufacture without compromising on mechanical integrity. The use of "Age Hardenable Coloured Carat Golds" is a possible solution to this dilemma discussed by Greg Raykhtsaum (Sigmund Cohn Corp, USA), based on work conducted earlier at Leach & Garner. With a focus on 10-18 ct gold-copper-silver alloys with 3% zinc additions, he showed what is possible through age-hardening heat treatments in conventional alloys and discussed aspects such as dent resistance of hollow bangles. Using the L & G dent tester, he demonstrated that age-hardened 18 ct gold bangles, 14 g in weight and with a wall thickness of 0.005 ins, were much superior in dent resistance than ones made in regular, non-heat treated alloy at 0.007 ins wall thickness, with a weight of 19 g. The economic case is made for use of age-hardenable alloys!

An alternative approach is the use of low gold content products. Rick Greinke (Award Concepts Inc, USA) spoke about "Gold-Filled – Its usage in Jewellery Manufacturing". The discovery of this technique was made in Sheffield, UK

some two centuries ago and, as well as a bit of its history, Greinke reviewed the definition of 'gold-filled' products, their manufacture, alloy compositions and current usage. He also reviewed mass finishing and polishing, refining of scrap as well as some defects that can occur. It was an excellent review of the topic.

Unusual colours of gold featured strongly this year. Ulrich Klotz (FEM, Germany) spoke about an EU-funded research project in his presentation, "Blue and Purple Gold: Chance and Challenge". As well as reviewing the metallurgy and properties of gold-aluminium, gold-gallium and gold-indium purple and blue intermetallic alloys, this paper looked at surface coating techniques for putting the blue and purple intermetallics on the surface of carat golds or silver as a way of overcoming what are inherently brittle materials. These first studies showed coating techniques such as electroplating, dip-coating and powder melting to be promising and to have improved corrosion properties. He was followed by Joerg Fischer-Bühner (Legor, Italy) who looked at investment casting in his presentation, "New Opportunities for Blue and Purple Gold in Jewellery Castings", some of which was also part of the EU project. This work looked at fracture resistance and the effect of small additions of palladium to the basic gold-aluminium intermetallic composition as well as micro-alloying additions. Conventional investment casting was used and bi-metal casting with 14 ct yellow or white gold and 950 palladium also studied. This work showed that fracture resistance of 14 ct blue and 18 ct purple gold is improved by microalloying, with palladium additions enhancing this. Crack-free castings of jewellery could be produced. Bi-metal casting was also possible to produce multi-coloured jewellery. Corrosion resistance was improved by use of protective, transparent lacquers.

"On the Use of an Incremental Casting Technique to Obtain Colour Gradients in Jewellery Components" was the topic presented by Filipe Silva (University of Minho, Portugal). Using directional and controlled solidification techniques with different coloured carat gold powders, fed into the melt charge, he showed how colour gradients and decorative grain patterns can be obtained and used to make innovative jewellery.

Other precious metals

Alex Verdooren (Rio Grande, USA) enlightened delegates on a new pre-polishing technique for silver with his presentation, "Advantages and Limitations of Electro-mechanical Finishing". This embraced an explanation of the technical basis of the process and its attributes. These include faster polishing, good preservation of surface detail and no impingement damage. He showed the cost of consumables versus other polishing techniques to be favourable too. This has relevance to gold as a new machine for gold has now been developed.

Mark Grimwade (Consultant, UK) gave a presentation on the Goldsmiths project, "An Investigation into the Practical Application of New Sterling Silvers", which looked at how

some new ‘tarnish resistant’ silvers behave in the workshop. All were found to be practical materials, with strengths and weaknesses. Another approach to tarnish resistance was discussed by Marcus Actis Grande (Turin Polytechnic, Italy) who spoke about “Transparent Coatings applied in Jewellery: A Challenge for Success?”. Using Plasma-enhanced Chemical Vapour deposition (PE-CVD), he deposited thin non-stoichiometric silicon oxide coatings onto sterling silver and performed a range of corrosion, tarnish and wear tests. These showed that a 100nm coating gave the best improvement to corrosion and tarnish. Actis Grande concluded that PE-CVD can be one solution to improve corrosion and tarnish resistance of sterling silver. Wear test results are awaited. These coatings may have application to the other precious metals for improved wear resistance, especially where the alloys are relatively soft. However, the equipment is expensive and not affordable by most jewellers.

Casting of sterling silver alloys was also examined by Daniele Maggiani (ProGold, Italy) who studied “Evaluation of Hot Tearing in 925 Silver Alloys”. Constrained rod castings in a range of sterling alloy compositions (including alloys with silicon, zinc, germanium, gallium, tin and bismuth additions) were cast under a protective gas. A *Hot Tearing Susceptibility Index* (HTS) was developed and this work showed, in general, that alloying additions increased the HTS value, due to an increase in grain size and/or interdendritic segregation.

The interest in platinum group metals commenced with a presentation by Mark Danks (Johnson Matthey, New York). His topic was “The Precious Metal Price Equation” and he reviewed the price history of platinum and palladium. The year 2008 was one of mixed fortunes, with the price of platinum starting high, rising even further during the first half-year before dropping severely in October due to softening demand in both industrial and jewellery sectors, although there was some recovery at the year end. Mark Danks analysed the supply and demand for platinum and palladium and the reasons behind the price changes as well as the demand trends in jewellery for platinum and palladium. The high price of platinum inevitably had an impact on jewellery demand, whilst the favourable price of palladium over gold and platinum, coupled with improved technical knowledge, has led to an increase in demand in Europe and the USA.

On the technical side, Paolo Battaini (8853 SpA, Italy) gave a presentation on the casting of 950 palladium alloys, using an innovative melting technique borrowed from the dental industry. Titled “Production of Hard 950 Palladium-based Jewellery using an Arc Melting Method under Argon Protection”, Battaini showed how employing arc plasmas for melting (as in TIG welding) in the investment casting of palladium jewellery can overcome some of the problems found with the conventional casting process. In general, a 2-part platinum investment gave the best results. Detail reproduction was good with a smooth surface and there was no reaction between metal and investment. Normal casting of 950 Pd results in large dendritic grains but in this study,

metallographic examination revealed a moderate as-cast grain size of about 300µm with some microsegregation across dendrites, the grain size increasing a little in thicker sections. Battaini concluded that arc melting is a reliable method for investment casting of his 950 Pd alloy and that the short melting times and argon atmosphere help to avoid alloy contamination.

On the platinum front, Jurgen Maerz, Platinum Guild International USA, gave a presentation, “Historic Casting Methods” of 950 platinum alloys. This was a review of old methods used to cast platinum and, more specifically, to a project in which the old manual sling casting method was reproduced in a modern guise and shown to produce acceptable castings, but whirling hot molten platinum around one’s head may not meet modern workplace health & safety requirements however!

Manufacturing technology

Following on in his series of presentations on manufacture of wrought mill products, Klaus Weisner (Wieland, Germany) gave one on “Tube Manufacturing – Some Basics”. This was a good review of the various techniques used, especially focusing on the precious metals, with the pros and cons of each described.

Investment casting remains the mainstay process for jewellery and a masterclass in rubber mould production was given by Hubert Schuster (consultant, Italy) in his talk, “Innovative Mould Preparation and Cutting for Very Thin and high Precision Items”. Using several grades of rubber in selected areas of the mould, Schuster showed with slides and video clips the possibilities that can be achieved in sophisticated mould manufacture. Anyone in the investment casting business could learn a lot from this presentation. Following on, Tyler Teague (Jett Research, USA) gave an excellent paper, “Technical Model Making (It’s not just the size of your sprue that counts)” looking at various factors including adoption of traditional base metal casting techniques to jewellery, in particular the use of risers, to prevent shrinkage porosity. This is an innovative approach to a problem area in investment casting of the precious metal jewellery.

Looking to the future, Joe Strauss (HJE Co Inc, USA) gave an excellent overview of “Rapid Manufacturing and Precious Metals”. This was an outstanding summary of new developments in Rapid Manufacturing technologies being applied in the engineering industries and looking at how they may be applied to precious metal products, including jewellery, in the short term.

Science behind ancient craft techniques

Japanese metalworking and patination techniques have long fascinated us in the West. But until now there has been little scientific understanding behind the techniques and why certain ingredients are used in the recipes. That has now begun to change. Ciln O’Dubhghaill and Hywel Jones

(Sheffield Hallam University, UK) presented their work, “Japanese Irogane Alloys and Patination – A Study of Production and Applications”. Use of modern analytical techniques has helped to unlock the secrets of this craft technique and to determine what role each of the natural ingredients (plum vinegar, rokusho, etc) plays. Modern substitutes were identified in some instances and the better understanding has led to a more consistent and reliable process. Examples of Cólín’s work were shown. This was truly what the Santa Fe Symposium is all about – getting a better understanding and sharing the information.

Again at the craft end of the business, Chris Ploof (Chris Ploof Studio, USA) studied bond strength in the manufacture of billets in his paper, “Mokumé Gane – Billet Reductions and their Effects on Bond Strength”. He looked at the effect of diffusion bonding time and down-stream processing techniques on the bond strength of 14 ct palladium white gold/sterling silver layered billets reduced to 50% thickness. This showed that long diffusion times produced stronger billets and that different cold and hot reduction techniques result have a varying effect.

General

Burnishing of jewellery involves mechanical hammering of the surface and Gary Dawson (Aurum Corp, USA) looked at “The Hardening Effects of Mechanical Burnishing” on a range of jewellery alloys – sterling and a platinum-enhanced sterling silver, 14 ct yellow and white gold, 950 palladium and 950 platinum. Hardness was evaluated by the ‘Drop Hardness’ test, a simple comparative test. Dawson showed that burnishing by rotary and vibratory tumbling gave an increased hardness of the surface layer, with rotary having a larger hardening and giving a smoother surface. However, subsequent hand polishing can remove this hardened layer, removing any benefit that such hardening might confer. On the hardness aspect, John Wright (Consultant, UK) spoke on “Hardness and Hardenability” in which he took a closer look at the various hardness tests and how work hardening under the indenter during the measurement influences the hardness value measured.

Many jewellery factories have in-house assay laboratories and Raj Mishra (A1 Specialized Services & Supply Inc, USA) described “Fire Assay – Laboratory Design”, a discourse on the factors to be considered in setting up such laboratories. Lastly, Michael Jones (Evangel Arts, USA) looked at “Prototypes and models using Unconventional Methods and Materials”. This focused on use of plastic laminate materials and laser cutting and engraving to make components for prototype models from which rubber moulds can be produced for white metal castings.

Awards

A *Lifetime Achievement Award* was presented to Dr John C Wright, UK (a former consultant to World Gold Council) who has made a significant contribution over many years to further our knowledge and understanding in jewellery manufacture. He wrote the World Gold Council Technical Manual on gold jewellery manufacture, for example.

The *Research Award* went to Daniele Maggiani (ProGold, Italy) and the *Technology Award* to Tina Schnyder (MISA Journal). Alexander Auberson (Cartier, New York) won the *Industry Leader Award*, Teresa Fryé (Techform, USA) – the *Collaborative Research Award*, Joe Strauss – the *Applied Engineering Award*, and the *Ambassador Award* went to Linus Drogs (Au Enterprises, USA), Nicholas Krohn (Krohn Inc, USA) and Neil Bell (Red Sky Plating, USA).

The Santa Fe Symposium proceedings are published as a book and the PowerPoint presentations are available on CD. They can be obtained from the organisers at www.santafesymposium.org.

The 24th Santa Fe Symposium will be held in Albuquerque on 16 - 19 May 2010.

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