THE

SANTA FE SYMPOSIUM

ON JEWELRY MANUFACTURING TECHNOLOGY

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Edited By
Eddie Bell
**Jewelry and Health: Recent Updates**

**Dr. Andrea Basso**

Furthering our research concerning the analysis of the interaction of metal release and skin contact presented at the eighteenth Santa Fe Symposium®, this report is an update of the existing knowledge regarding the relationships existing between metals of interest in jewelry and contact dermatitis. The study deals with an investigation of 920 individuals submitted to patch tests where metals considered to be relevant for jewelry were studied. In this paper, preliminary results regarding the assessment of allergy by a modified patch-test method are also reported and discussed.

*Dr. Basso has been a Process Engineer and Researcher in the chemical industry for more than ten years. Currently, he is the Technical Director for LEGOR s.r.l. in Italy. He is a two-time recipient of the Santa Fe Symposium® Research Award. This is his third year presenting at the Symposium.*

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**Paolo Battaini**

The growing interest in white precious alloys drives the research of new materials that could satisfy the market requirements. What requires deeper study is the use of 950 palladium-based alloys. The use of palladium provides many of the interesting features of platinum alloys at a lower price. This study is aimed at describing the effect of mechanical working, thermal treatments and welding operations on two prototype alloys. The first prototype alloy has a medium hardness. The second one shows the possibility of an increase in hardness up to 170 HV in as-cast metal and up to 270 HV in cold-worked metal. The problems encountered during the most common working operations, such as the production of wires, rings or tubes, will be discussed. This study also aims to show the procedure for establishing the working cycles on the basis of microstructural investigation.

*Mr. Battaini has a degree in nuclear engineering, is a Consulting Engineer with 8853 S.p.A. and a Professor of Precious Metal Working Technologies at Milano Bicocca University. This is his first year presenting at the Symposium.*
Textile Techniques in Metal: A Designer's Perspective on Sheet and Wire, Part II

Barbara Berk

This paper explores the application of textile techniques to metals. A broad selection of contemporary jewelry, objects and sculpture—all made with the very familiar forms of gold, platinum, silver and copper sheet and wire—is presented. A review of the weaving, basketry and braiding techniques presented at the 2004 Santa Fe Symposium® will lay the foundation for an examination of knitting, crocheting and lace-making techniques. Textile structures are analyzed using examples from studio artists, designers and manufacturers. Design and technical considerations of materials, form and function, and the hand tools or machines required to produce the work are discussed.

Barbara Berk is the author of “A Platinum Tapestry: Weaving All the Elements Together,” published in Platinum Manufacturing Process Volume VIII, Platinum Guild International USA (2000). Her jewelry is featured in Art Jewelry Today by Dona Z. Meilach (2003) and in Textile Techniques in Metal by Arline M. Fisch (1996 and 2001). She made her trade show debut as a Rising Star at the JCK International Jewelry Show. She is the recipient of a 2004 AGTA Spectrum Award, the 2002 Award for Excellence in Design from the Women's Jewelry Association and a first place award in the 2001 Saul Bell Design Award competition. This is her second year presenting.

"Where Can I Find What I Want to Know?"
Sources of Technical Information
For Jewelers

Dr. Christopher Corti

Got a problem? Need to know at what temperature to anneal white gold? The best practice in lost-wax casting of silver? How to overcome manufacturing problems with platinum? The pros and cons of different CAD software? Which companies sell RP equipment? Maybe you need to know what patents there are on micro-alloyed golds. Is nickel allowed in jewelry sold in Europe? Or perhaps you need basic material and videos to train your staff. Where does one find this information? How does one access it? Which sources are good, reliable and easy to understand? This presentation reviews the various sources of technical information of interest to jewelers and manufacturers and attempts to provide a basic guide to sourcing such information.

Dr. Corti holds a Ph.D. in Metallurgy from the University of Surrey (UK) and is currently a consultant for the World Gold Council and the Worshipful Company of Goldsmiths in London. He served as Editor of Gold Technology magazine and currently edits Gold Bulletin journal, the Goldsmiths' Company Technical Bulletin and the magazine, Technology. A recipient of the Santa Fe Symposium® Research Award, Technology Award and Ambassador Award, he is a frequent presenter at the Symposium.
Gary Dawson

Within the last several years there have been several metallurgical innovations aimed at improving the tarnish resistance and metallurgical properties of sterling silver alloy. Two new alloys in particular have the promise to revolutionize the process of working with sterling silver. First, the inclusion of 3.5% to 5% platinum in a new sterling silver is reported to significantly improve tarnish resistance and workability. And the inclusion of germanium in another new sterling alloy (called Argentium®) also reportedly improves tarnish resistance, workability and is reported to have the ability to be heat-treated to a harder state than traditional sterling silver. Neither of these alloys has been tested against the conventional sterling silver which contains 7.5% copper. We propose to perform a series of experiments designed to compare the relative hardness of platinum-enhanced sterling, Argentium® sterling, a traditional sterling alloy and pure silver in three states of hardness: fully annealed, rolled (as received from refiner) and fully hardened.

Mr. Dawson established Goldworks Jewelry Arts Studio in 1975 and has been involved in every facet of its operation since then, including design, research and studio benchwork. He has been an instructor in jewelry and metalsmithing, conducted in-studio seminars and has been a frequent contributor to AJM Magazine on a variety of topics. This is his second presentation for the Symposium.

Anthony Eccles

Typically, silver for use in jewelry is refined to 99.9% purity. This is pure enough for creating standard sterling silver, which only has 7.5% copper added to it to attain the working qualities silversmiths and jewelers have become accustomed to over several hundred years. Although the working qualities of traditional sterling silver are wonderful, the major drawback is firescale/stain that is commonly formed when soldering or casting. To overcome this problem, anti-firescale sterling silver alloys have been developed over the last 10 years. These alloys are more complex, making it essential to know the quality of all alloying components as well as the major metal being alloyed. In working to improve the casting quality of our firescale-free silver alloys, some trace elements still present in the refined silver were discovered to be causing problems. This study discusses the presence of very small quantities of some trace elements—in particular tellurium, selenium, bismuth and antimony—which, although present in only a few parts-per-million, can represent a threat to the production of quality, stable, silver casting.

Mr. Eccles is Managing Director of the custom casting company he founded in 1964. He designed several novel precious metal alloys that are in use worldwide. At previous
Santa Fe Symposia® he has presented papers on alloying precious metals and has been awarded both the Industry Leader and Ambassador Awards. In 2003, he was appointed Officer of the Order of Australia (AO) for service to the jewelry craft and to the technical education through the promotion of traineeship programs in Australia and overseas. This is his fourth presentation for the Symposium.

Twenty Years of Santa Fe Symposia®: A Progress of Knowledge and Production Technology 173-192

Dr. Valerio Faccenda

For 20 years, the Santa Fe Symposium® has proven to be a very important forum where goldsmiths and research scientists meet to share and discuss research results and practical experience, to network with colleagues and seek ways of solving practical problems. In achieving these objectives, it has been necessary to lower the barriers—created by wariness—that have always characterized the industry. In this presentation, we will illustrate the most important topics that have been discussed in these years, with special emphasis on investment casting, alloys and alloy treatment, powder metallurgy, factory organization and safety and health protection.

Dr. Faccenda is a metallurgical consultant and has served as a consultant to The World Gold Council. He is a recipient of the Santa Fe Symposium® Ambassador Award. This is his eighth presentation for the Symposium.

Computer Simulation of Investment Casting 193-216

Dr. Jörg Fischer-Bühner

Computer simulation of investment casting is not an easy process to control, especially considering the material and process variables, the many interrelations and the sources for defect generation. But, it can be a tool to improve our understanding of the process and give us, for example, an insight into metal flow during filling as well as temperature profiles of metal and investment material, especially during the cooling and solidification of the metal. Conclusions about avoiding defects, particularly shrinkage porosity, could be expected from this first sample modeling. The aim of this paper is to demonstrate the capabilities and limitations offered by the first sample modeling.

Dr. Fischer-Bühner holds a Ph.D. in physical metallurgy and materials technology. Since 1997, he has been employed at the Research Institute for Precious Metals and Metal Chemistry (FEM) in Schwäbisch Gmünd, Germany. Since 2001, he has been head of the Physical Metallurgy and Precious Metals Research division of FEM. He has received the Research, Ambassador and Collaborative Research Awards from the Santa Fe Symposium®. This is the paper he presented at the 2005 Symposium.
**Improvement of Sterling Silver Investment Casting**

Dr. Jörg Fischer-Bühner

This study will review the main results of a former European CRAFT Project, which focused on reduction of defects like firestain, hot cracking and porosity. The basic defect mechanisms will be explained, major sources identified and practical measures to avoid the related casting defects will be suggested. Concrete case studies on these defects and examples for successful industrial implementation of some suggested measures will be presented. The project has been carried out in cooperation with six investment casting companies from four European countries, an investment casting equipment manufacturer, an alloy manufacturer, as well as three European research organizations. The results have been worked out based on defect case studies, lab casting trials, computer simulation and, eventually, industrial casting trials based on obtained results and worked-out concrete recommendations. The study's challenges and results will be presented in detail.

Dr. Fischer-Bühner holds a Ph.D. in physical metallurgy and materials technology. Since 1997, he has been employed at the Research Institute for Precious Metals and Metal Chemistry (FEM) in Schwäbisch Gmünd, Germany. Since 2001, he has been head of the Physical Metallurgy and Precious Metals Research division of FEM. He has received the Research, Ambassador and Collaborative Research Awards from the Santa Fe Symposium®. This is his fifth year presenting.

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**Palladium Casting: An Overview of Essential Considerations**

Teresa Fryé

Palladium is experiencing increased popularity as a metal for use in the making of fine jewelry. Until recently, the casting of palladium for jewelry applications was rare in North America. Design suitability, casting techniques, metallurgical characteristics and finishing methods are not yet well developed in our industry. This paper focuses on the fundamentals for successfully casting this challenging metal, including sprue techniques, casting equipment and parameters, post-cast processing and alloy characteristics. In addition, basic attributes of the metal such as hardness, setting ability and wear resistance will be addressed.

Teresa Fryé has more than 18 years of experience working in the investment casting industry. She spent her early years in sales and marketing for Precision Castparts Corp. and serving the broad international customer base for aerospace castings in Europe and Japan. In 1994, she co-founded TechForm Advanced Casting Technology. TechForm initiated its business serving the medical and aerospace markets, entering the jewelry industry in 1995 and specializing in platinum and other high-temperature metals. This is her first year presenting at the Symposium.
Mokumé Gane: An Investigation into the Diffusion Bonding Characteristics of Difficult Alloy Combinations

Stewart Grice

This paper will investigate the diffusion reactions between two systems: 18K yellow gold to platinum alloys and 14K yellow gold to 14K palladium white gold. Physical, mechanical and crystallographic data will be determined for each diffusion bond and used to determine suitable heat treatments for the mokumé gane jeweler to avoid or to minimize the formation of brittle phases. The result will be to minimize process failures and maximize billet yields through heat treatment, forging and rolling to provide stock dimensions suitable for making jewelry.

Mr. Grice is the Mill and Refining Director at Hoover & Strong, Inc. He is the recipient of the Santa Fe Symposium® Ambassador Award and a two-time recipient of both the Collaborative Research and Research Awards. This is his sixth presentation for the Symposium.

Low-Karat Gold Investment Casting Alloys: The Effect of Silicon on Solidification and Devesting

Stewart Grice

A conclusion to research undertaken in 1999 that analyzed failures in silicon containing low-karat investment casting alloys, this paper concentrates on identifying the deleterious phases and proposing mechanisms for their formation and for the overall failure of the casting. For the study, a 10K yellow gold investment casting alloy from the Au-Ag-Cu-Zn system was analyzed in order to determine the effect of silicon additions and composition changes on performance during investment casting. Additions of silicon and varying the Ag-Cu-Zn ratio were determined to affect the formation of the phases and the subsequent performance of the alloy during solidification and devesting. Armed with this information, the jewelry caster can make informed decisions regarding the devesting process when casting high-silicon/low-karat gold alloys.

Mr. Grice is the Mill and Refining Director at Hoover & Strong, Inc. He is the recipient of the Santa Fe Symposium® Ambassador Award and a two-time recipient of both the Collaborative Research and Research Awards. This is his sixth presentation for the Symposium.
Kevin Lindsey

Tungsten Inert Gas Welding is a widely preferred method of joining metal in a large number of industries. Though the automated form is used for continuous welding of precious metal tubing by some manufacturers, the manual method has been overlooked by most silver-, gold- and platinum-smiths for 50 years. With the general acceptance and application of laser and pulse-arc welding, it is time to look at the uses of this common technology. This presentation will examine the use of modern inverter TIG welding machines in the repair and fabrication of precious metal jewelry. The discussion will cover the practicality, implementation, adaptability and uniqueness of this process as a solution for small shops and large manufacturers.

Mr. Lindsey is the owner of Lindsey Jewelers, which he founded in 1985. He has been continuously employed as a gold- and platinum-smith since the age of 17. He is the last state-certified jeweler apprentice in Oregon. He was among the 100 finalists representing the Americas in the 1988 DeBeers Diamonds International Design Contest. This is his first presentation for the Symposium.

John C. McCloskey

The microsegregation of alloying elements during the solidification of metallic alloys is a concept that is difficult to evaluate in complex alloys. Predicting the degree of microsegregation, which will occur in an alloy system, requires accurate values for the partition coefficients that describe the concentrations of alloying elements in solid and liquid phases during the freezing process. Values for partition coefficients can be determined from phase diagrams for binary alloys. Karat gold jewelry alloys typically contain three or four major alloying elements, and phase diagrams, if available, cannot be used to determine values for partition coefficients. Platinum jewelry alloys are unusual in that several binary platinum alloys are in common use for jewelry applications. Solute redistribution during the solidification of Pt-Co, Pt-Ru and systems was calculated and compared with results obtained in commercial investment casting procedures. An effort was made to compare and contrast microsegregation in Pt casting alloys with solute redistribution patterns in typical 14K yellow and white gold jewelry alloys.

Mr. McCloskey is Executive Director of Metals Technology for Stuller, Inc. He is a formally trained metallurgist with more than 25 years of experience. He introduced grain-refined 14K yellow casting alloys and is responsible for many process developments in investment casting and fabricated metals. Mr. McCloskey is the recipient of several awards, including the Santa Fe Symposium® Research and Ambassador Awards. This is his sixth presentation for the Symposium, including its inaugural year.
Important Parameters That Influence the Result in Mass-Finishing . . . . . . . . . . . . .377–386

Martin Moser

In mass-finishing there are many important parameters which will influence the result regarding speed and quality of your finished jewelry. The type of the machine, the quality of the media and the method of processing are important parameters, among others. Also, the settings on the machine itself play an important role. Let us show you how you can get better, faster, ready-to-sell results by fine-tuning your mass-finishing.

Mr. Moser is the Managing Director for OTEC Präzisionfinish, a company that holds more than ten patents for polishing machines. He has worked with surface finishing for 17 years. He is the recipient of the Santa Fe Symposium® Research and Ambassador Awards. This is his third presentation at the Symposium.

Dynamics of the Restricted Feed Tree . . . . . . . . . . . . .387–420

Apollonius Nooten-Boom II

This paper is a study of the dynamics that take place during the casting cycle of trees built with a thin primary feed system as first demonstrated by Jurgen Maerz. The paper will show the pattern of the fill process and will analyze the influences of pressure, centrifugal force, rotational deflection and gravity during casting. Further, it will be shown why this system is better for quality, surface finish and fine complex form filling than a conventional tree build style. The outcome of this research has resulted in a technique whereby counter gravity of platinum is achieved in a horizontal centrifugal casting machine.

Mr. Nooten-Boom II and his company, Hean Studio, have always been at the industry’s leading edge with new technologies, having custom-built many pieces of machinery. The latest development is a CAD/CAM department to benefit the company’s customers. Mr. Nooten-Boom is the recipient of the Caster of the Year Award in 1992, the Top Performing Company in Hereforshire Award in 1999, 2001 and 2005, and has twice received the Santa Fe Symposium® Industry Leader Award. He is also a Fellow of the Institute of Professional Goldsmiths (Master Caster). This is his fourth year presenting at the Santa Fe Symposium.
Titanium Casting and Working Process for Jewelry Manufacturing . . . . . . .421–434

Dr. Hubert Schuster

Ever-increasing in popularity, titanium offers a low-cost addition to gold and silver jewelry with interesting characteristics and effects. Jewelers and their customers appreciate its color, low weight and biological inertness. Titanium can be cold-worked and cast as well, but requires particular techniques, tools, machines and material in order to achieve the right result. This presentation will transfer the know-how and describe the following processing techniques: casting techniques with several special machines and materials; first world's stone-in-place casting with a list of suitable stones; several cold-working processes and their required tools and machines; possible hand-working processes and particular tools; particular soldering and linking techniques; and adequate finishing techniques and effects, including a special anodizing (coloring) technique and some samples of finished jewelry.

Dr. Schuster, Director of Jewelry Technology Institute in Creazzo, Italy, has more than 30 years of experience in jewelry production. He holds four patents for jewelry applications and has served as a technical consultant for more than 110 major companies worldwide. He is a recipient of the Santa Fe Symposium® Applied Engineering Award. This is his fifth presentation for the Symposium.

Fundamentals of the Shotting/Graining Process . . . . . . . . . . . . . . . . . . . . . . . . .435–472

Dr. Joseph Tunick Strauss

The production of grain or shot is universally practiced in the metals industry to produce an easily and conveniently handled product for subsequent processing. As common as this technology is, however, it is very complex. There are many misconceptions of the process and the cause and effect relationships between the numerous parameters. This work will describe the fundamental shotting process in terms of the physics and metallurgy that are related to and control the shotting mechanism. In addition, parameters that influence the process will be addressed.

Dr. Strauss is president of HJE Company, Inc., and the author of more than 20 published works. This is his seventh year presenting at the Symposium.
Barrie-John Williams

Traditionally, palladium has been used in jewelry manufacture mainly as an alloying element for white gold. Yet, in the past two years, it has become a significant jewelry material in its own right. Although most of the volume manufacture and sales have been in China, jewelry and watch companies in many other parts of the world—including the USA, UK and Switzerland—have started to put together palladium ranges and bring them to market. Well suited for the jewelry manufacturer, palladium is malleable, naturally white, takes a good polish, doesn’t tarnish and—when alloyed to ISO-recognized 950 ppt purity—is tough. It is a light metal and has a similar density to silver. Although its price has fluctuated considerably in the past, it is currently relatively stable at a little more than half that of gold and a quarter that of platinum. Light, bright and precious, for someone who can’t afford platinum, palladium offers an interesting alternative to the traditional default: white gold.

Mr. Williams is the Sales and Marketing Manager of platinum jewelry products at Johnson Matthey. He has a degree in Chemical Engineering with Minerals Processing. He was awarded the W. H. Haffenden Prize at the University of Birmingham, UK. This is his first presentation for the Symposium.

What Can We Expect From a Precious Metal Semi-Finished Product? 487-512

Klaus Wiesner

Semi-finished materials such as sheet, wire and tubing have a variety of properties. The alloy itself also strongly influences parameters such as hardness, density, strength, elongation, etc. This is well known by technicians and goldsmiths. But certain other parameters such as material form, flatness, straightness, surface quality, thickness tolerance, roundness, length and width are not so well known. Buyers and specifiers are often unaware what suppliers are able to offer and thus what standards are realistic expectations when placing orders. This can lead to delivery/quality problems for both customer and supplier, a scenario that depicts the importance of understanding semi-finished products.

Mr. Wiesner has more than 20 years of experience with precious metals. He is in Research & Development and is Sales Manager for EVE Ernst Vetler, GmbH in Pforzheim, Germany. He is a recipient of the Santa Fe Symposium® Ambassador Award; this is his sixth year presenting at the Symposium.