In The News

How to Calibrate Working Test Sieves

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Summary

Procedures for calibrating working/production test sieves are outlined. A master set of sieves is required, which ultimately becomes the most important part of the calibration process.

Introduction

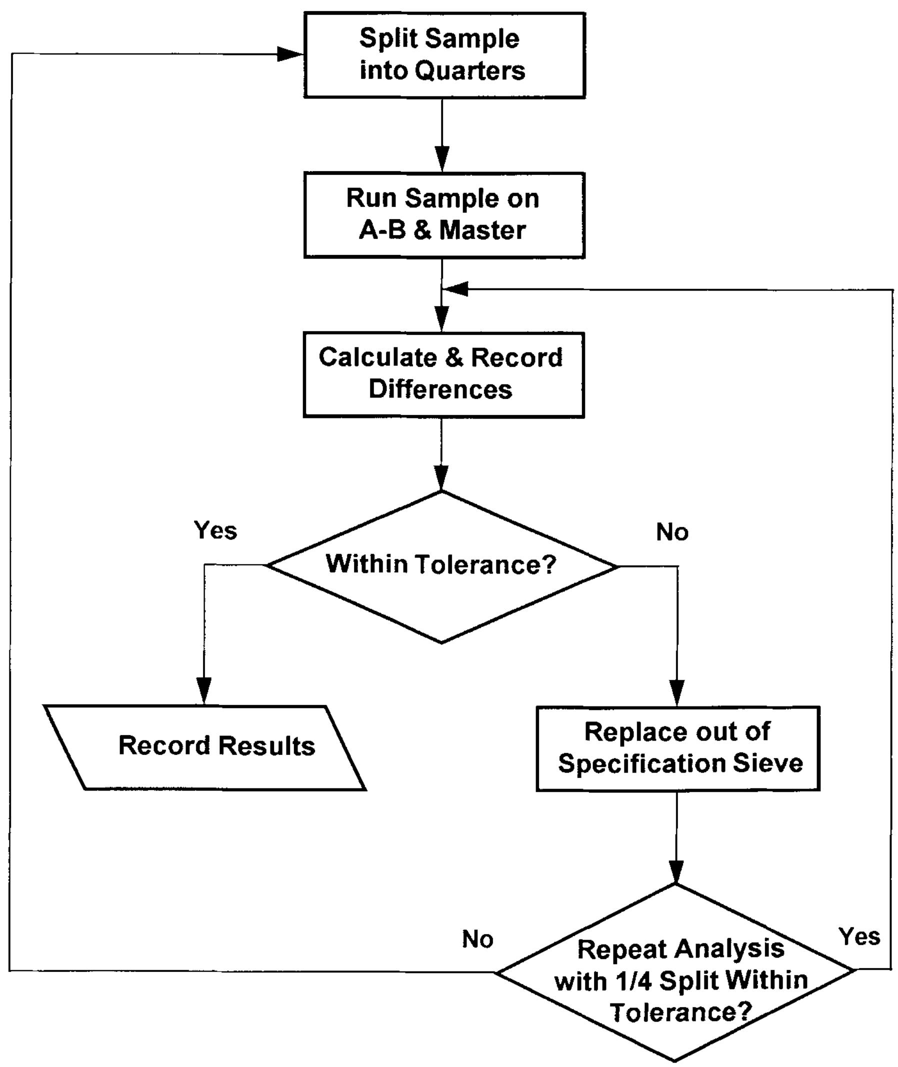
The heightened interest in improving the quality control of test-sieving programs is, in part, the result of increasing pressures for ISO 9000 certification. Almost daily, we are asked the question: How do I calibrate my working test sieves? There are two common, recognized ways to calibrate test sieves; conduct calibration tests using glass spheres; and physically examine each sieve using microscopic projection. Used correctly, both methods are accurate. However, they are complex and can be difficult if the calibration is not done every day.

As a result, the lab technician concerned with getting the daily production done is not inclined to take on a glass bead calibration procedure. Similarly, optical compactors are expensive and are rarely cost-effective in a production facility. As a consequence of working with many quality control people in a variety of industries, I set out to develop an alternative method to calibrate working test sieves. The goal: an easy and inexpensive calibration procedure.

At the outset, use certified test sieves. A certified test sieve is one that complies with a national or international standard. An American Society for Testing and Materials (ASTM) certification ensures that the sieve openings are within the plus or minus tolerance allowed in ASTM E-11-87. A master set of sieves is needed as the standard against which working sieves are checked. The two types of certified sieves commonly used for master sets are certified and certified mid-point. My recommendation is the mid-point set. Mid-point sieves are certified that the openings fall in the middle (±3μm) of the ASTM E-11-87 specification. Mid-point sieves provide a solid foundation for a dependable sieve calibration system. Although not recommended, a new set of calibrated sieves could be used.

The sieves from a master set should only be used to calibrate working sieves. These should never be used in regular sieving operations and then reused in a master set. If a sieve from a master set is used in an operational test, it should be marked as a working sieve and a replacement purchased for the master set. Great care should be taken when

Sieve Calibration Process



handling and cleaning the master set of sieves. The master set is the standard, and the most important part of this calibration process.

Working Sieves

If you have more than one working stack of test sieves, it is important that the individual sieves in a stack be used together. One of the most effective ways to ensure stack trueness is to keep a record of the serial numbers of each sieve in each working stack.

Another way is to mark each sieve with a stack identification. These techniques will ensure that you have a valid calibration tracking procedure. This will eliminate corruption of the results that would occur if the individual sieves in a stack were switched at the time of calibration. One sieve from another stack will corrupt your results.

Calibrated Samples

Glass spheres or calibrated samples are available from industry associations or NIST. Unless customers or other product specifications call for the aforementioned, it is recommended that the material used for calibrating be from a representative sample of the product being tested in your operations. This provides a calibration basis that translates easily to operation procedures.

The first step in preparing the material for a calibration standard is to split a sample into quarters. Use either a manual or mechanical device. A hand sample divider that splits samples into quarters will work fine.

Calibration Setup

The results of processing a part of the calibration sample through the master stack will be compared to the results of processing a second part of the calibration sample through the working stack. This comparison is the means to identify the need to replace working sieves that are out of tolerance because of wear or breakage, which will distort operating results.

The steps that will ensure effective calibration data are:

- Split the sample into four representative samples.
- Weigh and record the four representative samples.
- Place the master set of sieves on the sieve shaker. Use one-quarter of the sample that was split and run a test. It is important that the same shaker and the same settings are used for all calibration tests. It is recommended that the same person run all of the calibrating tests.
- Record the weight retained in each sieve. It is easier to compare the results if they are calculated to percent retained.
- Place a working set of sieves on your sieve shaker. Use one-quarter of the sample, and run a test. Note that it is critical that the same shaker and settings are used as in the test that used the master set.
- Record the weight retained in each sieve and convert to the percent retained.
- Compare the results from the master set of sieves with the results of the working set.
- Record the difference retained in each sieve of the working set versus the same sieve in the master set. This difference is the allowable curve Keep these records on file for future reference. You will use the same curve every time you calibrate.

This last step completes the establishment of a calibration standard. The next procedure deals with the actual calibration of the working sieves.

Calibration

Once the calibration steps have been completed and the calculations finished, the evaluation of the working set needs to be done. Compare the difference of the allowable curve established with the difference in the calibration test. If your results are not within the tolerances you have specified, the out-of tolerance sieves should be identified and replaced with new calibrated sieves.

To make this testing procedure produce traceable and practical product-quality standards, it is recommended that:

- Frequency of performing calibration checks on working sieves be established and implemented
- Based upon the frequency of calibration checks, a replacement schedule should be established for the master sieves.

The frequency of these tests and replacements should be based upon operational test schedules, sieve maintenance procedures, the characteristics of the material tested and the tolerances for acceptable quality standards.

With this procedure, most of the mystery and complexity can be removed from a sieve-calibration program.

Editor's Note: This article was adapted from a paper presented at Powder & Bulk Solids '93, Rosemont, IL, and published with the permission of the author. It originally appeared as a manuscript in Ceramic Industry, 141 [4] (September. 1993) 68-69 and is reprinted with permission.

News from NASA

Desulfurization of gas-turbine blades has been proposed at Langley Research Center (Hampton, Virginia) by a glow-discharge cleaning process. Sulfur can be removed from the nickel-base superalloy used to make gas-turbine blades by heating the alloy and simultaneously subjecting it to sputtering by directed Ar^+ ions from an ion gun or from a glow discharge. Reduction of the sulfur content of the superalloy by a factor of 10 could increase the lifetime of a turbine blade made of this alloy by a similar factor, because the stability of the protective surface oxide formed during operation of the turbine would be increased.

A thin and continuous scale or film of Al_2O_3 that forms on the surface of an advanced nickel-base superalloy protects the underlying alloy from further oxidative attack at temperatures above 980 °C. It has been found, however, that the segregation of indigenous sulfur to the alloy/oxide interface induces the otherwise adherent aluminum oxide scale to spall during thermal cycling (see Fig. 1). The present method to pre-

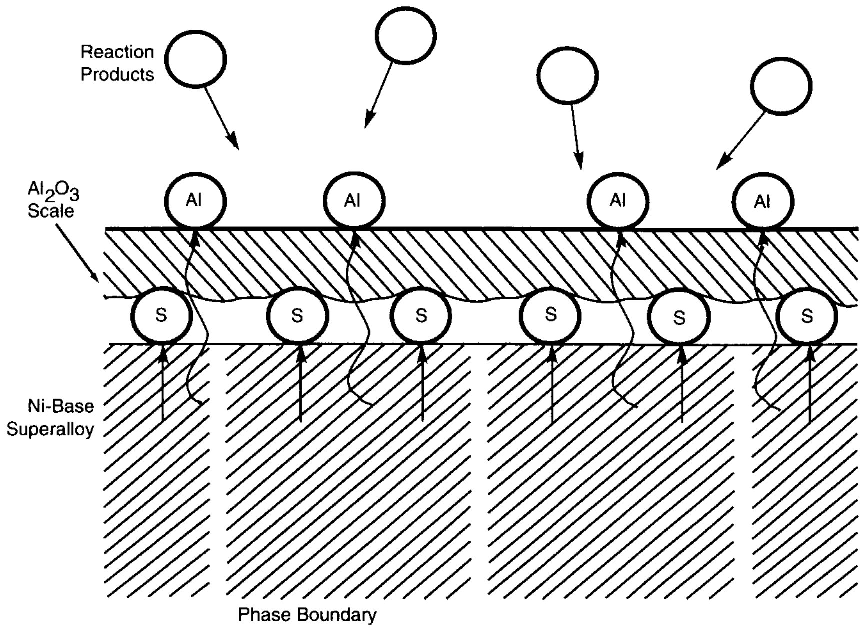


Fig. 1 A Protective Scale of Al_2O_3 forms on the surface of a turbine blade. However, segregation of sulfur to the surface causes spallation of the Al_2O_3 scale.

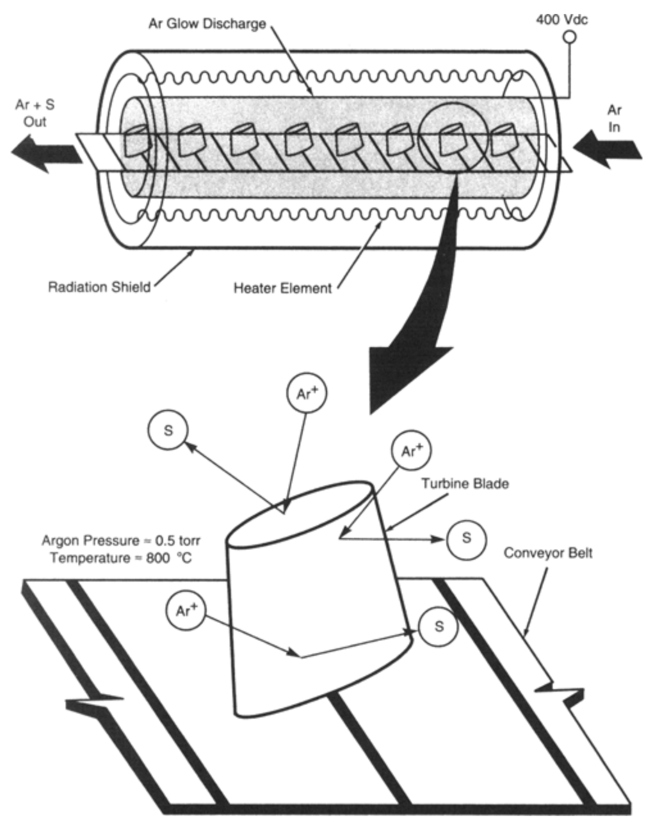


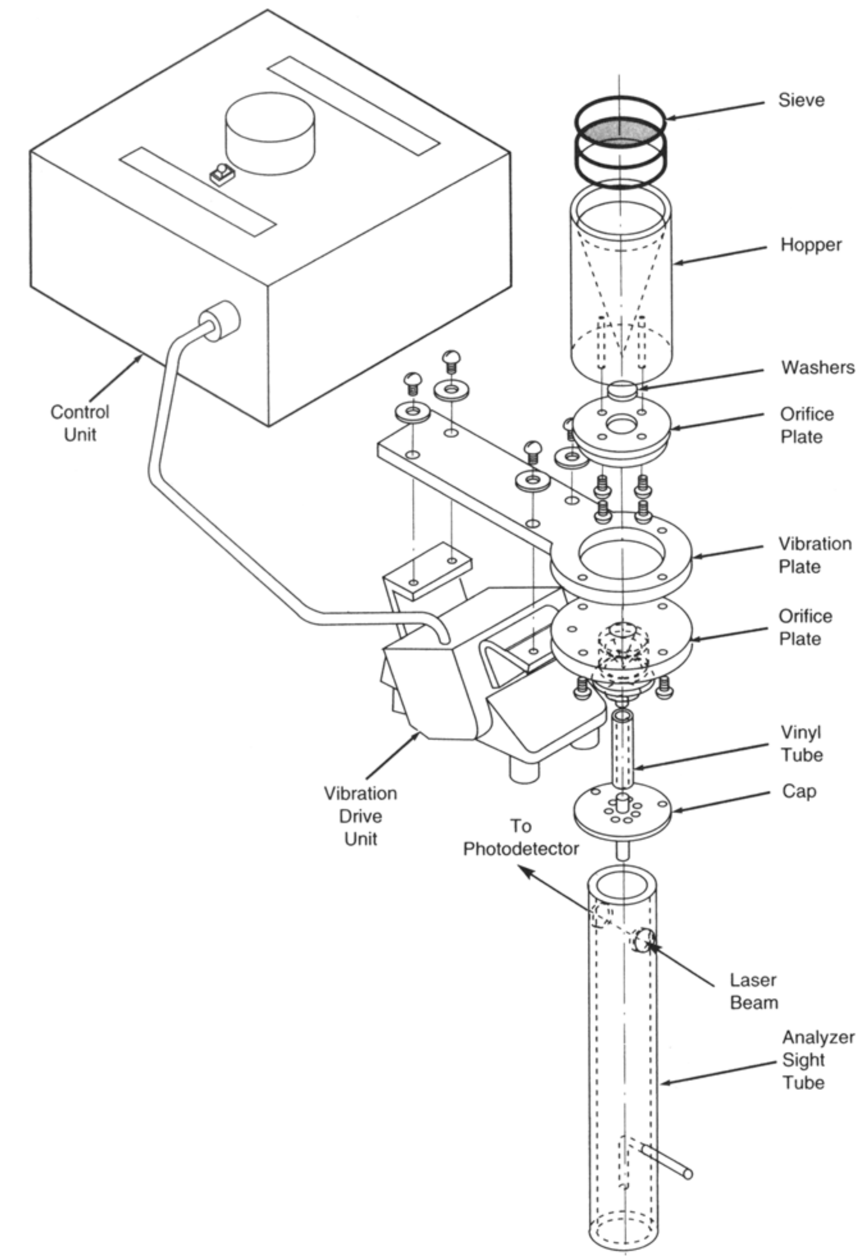
Fig. 2 Gas-Turbine Blades made of Ni-based superalloy would be desulfurized by simultaneous heating and exposure to a glow discharge in flowing argon gas.

vent this spalling is to add small, precise amounts of yttrium and other lanthanides to the melt of the Ni-based superalloy to react chemically with the sulfur and form stable sulfides that lock up the sulfur and prevent it from segregating to the interface between the bulk alloy and the Al_2O_3 overlayer. However, the inherent reactivity of yttrium and other lanthanide elements requires an exceptionally high degree of control over the alloy chemistry during melting and casting, which often gives an inferior blade.

Figure 2 illustrates the glow-discharge version of the proposed sputtering/heating desulfurization process. Extrapolating from previous research on a Ti/Al/Nb alloy, it is expected that heating the nickel superalloy to a temperature of about 800 °C should result in dissolution of the surface carbon and oxygen followed by the subsequent segregation of sulfur to the grain boundaries, phase boundaries, and then to the interface or surface, from whence it would be depleted by impact of Ar^+ ions. A viscous flow of argon at a pressure between 0.1 torr (about 13 Pa) and 5 torr (about 0.7 kPa) would remove the sulfur from the vicinity of the surface, thereby preventing re-adsorption. (This flow would have to be turned off during ion-gun sputtering because of the need for a large mean free path for the ions.) In the glow-discharge version of the process, the speed of the conveyor belt would be such that the blades would be in the heater-tube/glow-discharge region for a sufficient time to deplete the sulfur in the turbine blades. This time would be a function of the size and shape of the blades and of the time necessary for the sulfur to diffuse from the most distant regions of the bulk blade material to the surface. This technique is also amenable to a batch process.

This work was done by Ronald A. Outlaw of Langley Research Center. Inquires concerning rights for the commercial use of the invention should be addressed to the Patent Counsel (Dr. George F. Helfrich), Langley Research Center, Mail Stop 143, Hampton, VA 23681-0001. Phone (804) 864-3221. Refer to LAR-14784. This article is reprinted, with permission, from NASA Tech Briefs, Volume 18, Number 2, February 1994, Page 54.

A low-flow-rate dry-powder feeder has been proposed at Marshall Space Flight Center (Alabama) where the rates of flow are optimized for measurement of particle-size distributions. An apparatus feeds a small, precise flow of dry powder through the laser beam of an optical analyzer, which measures the patterns of



Powder falls from a hopper through orifices, passing through a laser beam. A control unit regulates vibration to provide a slow, uniform flow.

light created by forward scattering (Fraunhofer diffraction) of the laser beam from the powder particles. From this optical measurement, the statistical distribution of the sizes of the powder particles is computed.

The powder-feeding apparatus provides the steady flow that is neither too dense nor too sparse for creation of the required diffraction patterns. Flow at too high a rate would be too dense in that it would result in multiple scattering; the optical analyzer would measure two or more particles at the same time and indicate a smaller particle than was actually there. Flow at too low a rate would be too sparse in that it would yield insufficient data for computation of the particle-size distribution. Too sparse a flow would also expose the photodetector in the optical analyzer to direct laser radiation in excess of its measurement range.

In the powder-feeding apparatus, the powder descends from a hopper through a series of orifices, which meter the flow (refer to the figure). The subassembly that contains the hopper and metering orifices is vibrated to prevent bridging of orifices and thereby ensure steady flow at the maximum rate permitted by the orifices. After flowing through the lowest metering orifice, the powder stream continues downward through a flexible tube into a vertical analyzer sight tube, where the laser beam intercepts the stream monitored by the photodetector. The powder continues to flow down the sight tube and is collected at the bottom. The collected powder can be reused.

The rate of flow can be changed by replacing the metering orifices with other orifices of different diameters. Rates of flow usually range from 0.2 to 0.4 g/s depending on the bulk density and the particle-size distributions of the powders. The feeder was developed for analyzing particle-size distributions of solid-propellant powders. The feeder could also be adapted to use in the pharmaceutical industry, in manufacture of metal powder, and in other applications in which the particle-size distributions of materials are used to control rates of chemical reactions and/or physical characteristics of processes.

This work was done by Keith E. Ramsey of GenCorp Aerojet for Marshall Space Flight Center. Contact the Technology Utilization Officer (Ismail Akbay), Code AT01 Marshall Space Flight Center, AL 35812, Phone (205) 544-2223, (800) 437-5186. Request MFS-28738.

Advanced Composites Technologies

Advanced Composites Technologies, covering the 9th Annual ACCE Conference, is available from ASM International. This 766 page book presents a focused overview of the latest developments in advanced composites, both plastic and metal. More than 50 technical papers cover design, materials, processing, structural composites and related supporting technologies used in automotive, aerospace and commercial products. Papers on processing cover liquid molding, forming and tooling. Papers about materials include both polymeric and metal matrix composites as well as their mechanical performance. The design track covers structural durability, crash management, recycling, cost modeling, quality control, nondestructive testing, and high-volume manufacturing options in automotive application.

Advanced Composites Technologies (ISBN: 0-87170-516-8) is available for $85 (ASM members $68). Contact ASM Member Services Center, Materials Park, OH 44073-0002. Phone: (216) 338-5151, Fax: (216) 338-4634. Refer to order #6269NR.

Testing and Failure Analysis Literature

The 400 page Proceedings of the International Symposium for Testing and Failure Analysis provides the latest developments in the advancement of techniques for failure analysis, screening, product evaluation, diagnostics and testing in the microelectronics industry. Information on advanced and practical techniques on defect location and analysis on thin films and microcircuits is presented. Designing for failure analysis with built-in diagnostics, fault-isolation methods, and software tools for failure analysis including computer-aided fault isolation are also discussed.

ISTFA '93: Proceedings of the International Symposium for Testing and Failure Analysis (ISBN: 0-87170-498-6) is available for $98 (ASM members $78.40). Contact ASM Member Services Center, ASM International, Materials Park, OH 44073-0002. Phone: (216) 338-5151, Fax: (216) 338-4634. Refer to order #2019NR.

Quantitative Microscopy and Image Analysis

Quantitative Microscopy and Image Analysis is a 135 page book containing 16 papers of the proceedings from the 1993 ASM Conference in Charleston, SC. The meeting covered computer-aided techniques for optical metallography and scanning electron/transmission electron microscopy.

More precise data for quality control and accurate analysis of complex control are examined along with the relationship between ultrasonic and metallographic measurements. Also discussed are the correlation between two- and three-dimensional distribution and accurate quantification of morphological features. Quantitative Microscopy and Image Analysis shows how accurate, reproducible measurements are being made from complex images which were previously difficult to analyze. It also covers visual assessment of global properties and correlation with ultrasonic measurements.

Other topics include: Mathematical Morphology Processing, Scanning Probe Microscopy, Infrared Sensing of Weld Penetration, Stereology of Anisotropic Microstructures, and Digital X-Ray Microscopy Mapping.

Quantitative and Image Analysis (ISBN: 0-87170-511-7) is available for $64 (ASM members $51.20). Contact ASM Member Services Center, ASM International, Materials Park, OH 44073-0002. Phone: (216) 338-5151, Fax: (216) 338-4634. Refer to order #6399NR.

Mechanical Alloying for Structural Applications

Mechanical Alloying for Structural Applications (468 pages) covers the proceedings of the 2nd International Conference on Structural Applications of Mechanical Alloying held in Vancouver, Canada in 1993. The book offers a unique blend of perspectives from users, fabricators, suppliers and academics. This book is dedicated to Professor Dr. Gerhard Jangg for his many contributions to MA technology and contains over 50 papers addressing the latest developments in this evolving field.

Topics include the working and heat treatment of MA materials to obtain unique microstructures. Properties and structure of dispersion-strengthened titanium-, aluminum-, copper-, and nickel-based alloys are discussed along with applications of iron, nickel, niobium and titanium aluminides in MA technology. Also covered are powder-making processes, subsequent consolidation, nickel-base superalloys, high-temperature aluminum composites, intermetallics, and characterization of mechanically alloyed materials including nanocrystalline, amorphous and nonequilibrium alloys.

Mechanical Alloying for Structural Applications (ISBN: 0-87170-492-7) is available for $125 (ASM members $100). Contact ASM Member Services Center, ASM International, Materials Park, OH 44073-0002. Phone: (216) 338-5151, Fax: (216) 338-4634. Refer to order #6529NR.

Conference On NDE Published

The 12th International Conference on NDE in the Nuclear and Pressure Vessel Industries is a 514 page book concerning the latest developments on improved operational procedures, better design and inspection, and more reliable quality control for the nuclear power industry. Its chief concern is the role of nondestructive evaluation (NDE) in ensuring the safe and economical operation of nuclear plants.

These reviewed and edited papers detail the latest developments and expertise in NDE for the nuclear power industry. Worldwide concern regarding more stringent NDE technology is reflected in nearly 100 submissions from England, Scotland, Germany, France, Belgium, Sweden, Russia, Italy, Spain, Japan, Taiwan, Canada and US. Topics include: performance-demonstration initiative (PDI), control drive-rod mechanisms, penetration weld inspection, as well as the inspection of steam generator tubes, turbines, pressure vessels, and bimetallic welds.

12th International Conference on NDE in the Nuclear and Pressure Vessel Industries (ISBN: 087170-506-0) is available for $100 (ASM member $80).

Contact ASM Member Services Center, ASM International, Materials Park, OH 44073-0002. Phone: (216) 338-5151, Fax: (216) 338-4634. Refer to order #6530NR.

Nickel and Chromium Plating, 3rd Edition

This 464 page book describes the industrial processes for carrying out nickel and chromium deposition, then relates them to the basic mechanisms critical to that operation. New material in the Third Edition reflects the move away from using nickel and chromium depositions for decorative and corrosion-resident purposes on mass-produced articles and towards their use for surface engineering requirements on a smaller number of more valuable products.

Material has been added, expanded or updated throughout with particular emphasis on environmental and health concerns, electroless (autocatalytic) nickel deposition, electroforming, alloy deposition, pulsed-current plating, and EMI/RFI shielding.

Topics covered include: Introduction and Historical Review, Metallurgical Aspects of Electrodeposition, Electroplating Baths and Anodes Used for Industrial Nickel Deposition, Engineering Application, Bright Nickel Electroplating, Control and Purification of Nickel Electroplating Solution, Physical and Mechanical Properties of Electrodeposits and Methods of Determination, Chromium Plating, Thickness and Corrosion Testing of Nickel Plus Chromium Platings, Decorative Nickel Plus Chromium Coating Combinations, Autocatalytic Deposition of Nickel, Electroplating Onto Plastics, Depositions of Nickel Alloys, Plating of Difficult-to-Plate Alloys, and High-Speed Plating.

Nickel and Chromium Plating, 3rd Edition (ISBN: 1-85573-081-2) is available for $122 (ASM member $97.60). Contact ASM Member Services Center, ASM International, Materials Park, OH 44073-0002. Phone: (216) 338-5151, Fax: (216) 338-4634. Refer to order #6337NR.

Heat Treating Equipment and Processes

International Heat Treating Conference: Equipment & Processes is available from ASM International. This 500 page book covers the 1994 proceedings.

Subject areas include: Vacuum Heat Treating, Furnace Developments, Use of Modeling Techniques, Gas and Fluid Quenching, Induction Heating Developments, Electronic Treating Processes, Quench Fluid Handling and Other Environmental Concerns, Heat Treating Atmospheres, Refractory Materials for Heat Treating Equipment, Atmospheric and Temperature Sensing, and Specific Materials Processing.

International Heat Treating Conference (ISBN: 0-87170-508-7) is available for $99 (ASM members $79.20). Contact ASM Member Services Center, ASM International, Materials Park, OH 44073-0002. Phone: (216) 338-5151, Fax: (216) 338-4634. Refer to order #6242NR.

Heat Treatment In Fluidized Bed Furnaces

Heat Treatment in Fluidized Bed Furnaces, written for the operators of the 3,000 metal processing furnaces in use worldwide, details and analyzes alternative basic designs available in fluidized beds. The author, Ray W. Reynoldson, has been an acknowledged expert in the field of heat treatment for the past 30 years, personally involved in the development of fluidized bed furnaces. Overseeing more than 500 installations, he has published papers on both fluidized bed and vacuum equipment in Australia, South East Asia and Japan.

The 250 page book provides a useful guide to equipment selection for most heat treating applications with extensive tables and figures for convenient referral. It covers the practical side of surface treating, tool and die steel heat treatment, cleaning, fixturing and costing, as well as introductory hard surface coating techniques. This book is of special value for practical heat treaters considering the use of fluidized bed equipment for the first time who need dependable reference information. Plant metallurgists will find it useful for its thorough analysis for the pros and cons of fluidized beds versus other types of equipment, and the precise details and performance characteristics of beds during treatment.

Heat Treatment in Fluidized Bed Furnaces (ISBN: 0-87170-485-4) is available for $78 (ASM members $62.40). Contact ASM Member Services Center, ASM International, Materials Park, OH 44073-0002. Phone: (216) 338-5151, Fax: (216) 338-4634. Refer to order #6330NR.

Carburizing: Processes and Applications 1994

A current, international study of developments and applications of carburizing operations for surface and case hardening is presented in the latest Industry Report, Carburizing: Processes and Applications 1994. Created by Materials Information, the Industry Reports Series is designed to provide comprehensive, organized corporate intelligence on materials related topics. Carburizing: Processes and Applications 1994 offers an organized presentation of research directions, new developments and current experience in carburizing materials to achieve desired properties.

The report covers new processes involving uses of laser, plasma and induction heating sources; the impact of varying treatment parameters on materials; the benefits of carburizing in terms of improved materials properties and increased component service life; the related operations, including machining and surface finishing processes; the citing of new alloy developments; and innovations in furnaces, atmospheres, automation and process control technology.

Carburizing: Processes and Applications 1994 details the activities of more than 500 corporations relating to the commercial operations and production systems designed to achieve application-specific qualities and dimensional accuracy in carburized materials. The report is organized in easy-to-use tables which serve as a directory to the array of steels and alloys cited and to the individual manufacturers, supplier companies, universities, institutes and associations involved in carburizing research and manufacturing enterprise worldwide.

An introductory editorial in Carburizing: Processes and Applications 1994 summarizes the issues, trends and developments impacting the application of carburizing in industries. The Appendix includes an international listing of related associations, organizations, societies and corporate organizations cited in the sources referenced. Also included with the report is a fully-documented personal computer diskette designed to help locate documents and store and retrieve documents found in a search.

To order Carburizing: Processes and Application 1994, $325 (North America), £180 (EC), $370 other countries, contact Ms. Debbie Barthelmes, Materials Information, ASM International, Materials Park, OH 44073-0002. Phone: (216) 338-5151, ext. 532. Fax: (216) 338-4634. Or contact Ms. Julie Lee, Materials Information, The Institute of Materials, 1 Carlton House Terrace, London SW1Y 5DB, England. Telephone: 071-839-4071. Fax: 071-839-2289.

The Encyclopedia of Advanced Materials

This reference work will be published by Pergamon (an imprint of Elsevier Science, Inc.) in four volumes by late 1994. The four Editors are David Bloor (University of Durham, UK), Richard J. Brook (University of Oxford, UK), Merton C. Flemings (Massachusetts Institute of Technology, USA) and Subhash Mahajan (Carnegie Mellon University, USA); with Senior Advisory Editor Robert W. Cahn (University of Cambridge, UK).

This new work was commissioned to companion the Encyclopedia of Materials Science & Engineering and its three Supplementary Volumes. This Encyclopedia provides the first and only complete treatment of the synthesis, processing theory and applications of all classes of advanced materials. It covers all major developments in Advanced Materials since the publication of The Encyclopedia of Materials Science and Engineering in 1986. There are over 550 articles which are intended to be the definitive reference source for the emerging field of Advanced Materials. This series contains extensive cross referencing, full indexes and bibliographies with each article.

The pre-publication price is US$1,200.00 for orders received before November 01, 1994 (US$1,600.00 after that date). Contact Elsevier Science, Inc., 660 White Plains Road, Tarrytown, NY 10591-5153, USA. Phone: (914) 524-9200, Fax: (914) 333-2444, email: r.seger@elsevier.com; or Elsevier Science Ltd., The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, UK. Phone +44 0865 843685, Fax: +44 0865 843946, email: s.hanlon@elsevier.co.uk.

Materials Information Offers Free Journals Listing

Materials Information has produced a booklet providing a complete listing of all the journals abstracted in METADEX, Engineered Materials Abstracts, the Materials Business File, and Aluminum Industry Abstracts. These bibliographic databases are a comprehensive source of information on metals and materials.

This free booklet provides the full name of each of the journals listed. Complete details, including the publisher name, address, years of coverage, ISSN and the abbreviated title are provided in Source Journals in Metals & Materials. More than 2,000 journals, covering all aspects of metallurgy, materials science and related fields of engineering, are indexed by Materials Information's two offices in London and Ohio. Business sources such as trade journals and newspapers are also acquired.

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Conference Announcements

International Symposium on Plasma Chemistry

The International Symposium on Plasma Chemistry (ISPC) is an international conference held biennially at various host institutions around the world. The ISPC is the main international plasma chemistry conference, encompassing the whole area of plasma chemistry including high pressure thermal plasmas, low pressure non-equilibrium plasmas, and corona discharges. Topics covered range from the basic physics and chemistry of these discharges to the study of industrial plasma processing techniques and equipment.

The conference is structured to facilitate the exchange of information and ideas between basic/applied researchers in plasma chemistry and industrial practitioners of plasma processing technology, within an international framework. ISPC-12 will consist of a five-day Symposium incorporating a Plasma Equipment Exposition, proceeded by a two-day Summer School on Plasma Chemistry and followed by a one-day Workshop on Industrial Applications of Plasma Processing.

The 12th International Symposium on Plasma Chemistry will be held August 21-25, 1995, at the University of Minnesota in Minneapolis, Minnesota, USA. The Symposium will consist of a series of parallel oral sessions (composed of both invited and contributed papers), poster sessions, and plenary lectures covering the entire field of plasma chemistry and plasma processing both in thermal and low pressure plasmas.

The Symposium, Equipment Exhibition, Workshop, and Summer School will all be held in facilities on the campus of the University of Minnesota in Minneapolis, Minnesota, USA. Accommodations will be available in campus dormitories and at several hotels adjoining the campus. The conference facilities are located adjacent to several campus-oriented restaurants and shops and about ten blocks from downtown Minneapolis, which hosts an abundance of restaurants, shops, financial institutions, entertainment facilities, and cultural activities.

Subjects covered will range from the fundamental science of these discharges to applications and engineering of plasma processing technologies. The main topics covered by the Symposium are:

- Modeling: elementary reaction processes; gaseous electronics; non-equilibrium DC, RF, ECR and IC discharge physics, chemistry and process design; corona discharges; thermal plasma generation, heat and mass transfer, plasma-particle interactions and torch design.

- Diagnostics: probe diagnostics; optical spectroscopy; LIF; mass spectroscopy.
- Volume Synthesis: gas synthesis; hazardous materials and waste treatment; solid particulate/powder synthesis; pyrolysis.
- Thin Film Processing: sputtering; etching; deposition of inorganic and polymeric films including diamond, amorphous silicon, and high T superconductors; cleaning; particulate contamination; plasma induced damage; hard and barrier coatings; biomedical coatings.
- Plasma Metallurgy: spraying; heating; melting; evaporation; extraction.
- Other Applications: ion and neutral beam sources; analytical chemistry including ICP and sample treatment; real time monitoring and control.

Proceedings of the Symposium will be available at the beginning of the conference. An exhibition of equipment for plasma diagnostics, instrumentation, and processing will be held during the Symposium. Admission to the Equipment Exhibition will be included in the Symposium registration fee. For further information on exhibiting at the Exhibition contact Prof. J. Heberlein, ISPC Chairman.

Abstracts are due January 31, 1995. Inquiries concerning the ISPC Conference, Exhibit, Summer School and Workshop can be addressed to: ISPC-12 Conference Office: c/o Catherine Ploetz, 218 Nolte Center, University of Minnesota, 315 Pillsbury Drive SE, Minneapolis, MN 55455, USA. Phone: (612) 626-2259, Fax: (612) 626-1632, Internet: ispc12@pdcs.cee.umn.edu, or The Conference Chair: Prof. J. Herberlein, Department of Mechanical Engineering, University of Minnesota, 111 Church St. SE, Minneapolis, MN 55455, USA. Phone: (612) 625-4538, Internet: jvrh@maroon.tc.umn.edu.

International Summer School of Plasma Chemistry

The International Summer School of Plasma Chemistry will be held prior to the ISPC Symposium, on August 17-19, 1995, at the University of Minnesota. The Summer School will consist of courses providing an introduction to the fundamentals and applications of plasma chemistry and plasma processing. Two courses will be offered simultaneously, one on low pressure non-equilibrium plasmas and the other on thermal plasma technology. These courses are intended for scientists, engineers, and managers who want an introduction and overview of the subject area. There will be a separate registration fee for the Summer School.

Workshop on Industrial Applications of Plasma Processing

A Workshop on Industrial Applications of Plasma Processing will be held following the ISPC Symposium on August 25-26, 1995, at the University of Minnesota. The Workshop will focus on recent industrial applications, developments, and concerns in thermal and low pressure plasma processing. The workshop will be designed to facilitate an open exchange of ideas between researchers, equipment manufacturers and end users. There will be a separate registration fee for the Workshop.

International Metallography Conference

A call for papers has been announced for the International Metallography Conference to be held 10-12 May 1995 in Colmar, France. The conference, sponsored by ASM International Europe and the International Metallographic Society, will serve as a meeting place of material scientists and engineers with interest in recent developments in metallography, microscopy and failure analysis. The papers are sought, but not limited to, topics such as new microscopic techniques and novel applications of conventional microscopy; image analysis and quantitative microscopy; fractographic and failure analysis; microscopy of coatings (including thermal sprayed coatings) and layered structures; and developments in metallographic preparation techniques. The main focus of the conference will be a search for the insight of the relation between microstructure, fabrication (synthesis and processing) and properties of materials. Parallel with the conference, a table top exhibition is planned for those companies interested to display capabilities to serve this particular scientific field. Papers not previously published and not commercially oriented will be accepted. Abstracts not exceeding 200 words and typed on a single page (A4) are requested for oral and poster presentations. Send abstracts before 1 November 1994 to Conference Secretariat, ASM International Europe, Att. Ms. Claudine Frischer, rue de l'Orme, 75, B-1040 Brussels, Belgium. Telephone: (32/2) 736.52. 11. Fax: (32/2) 733.43.84 or contact ASM Member Services Center, ASM International, Materials Park, OH 44073-0002. Phone: (216) 338-5151. Fax: (216) 338-4634.

ASM Historical Landmarks

The ASM Historical Landmark award was established in 1969 to preserve our engineered materials heritage while providing a means to increase the awareness of pioneering milestones in engineering materials technology. ASM Historical Landmarks are located in 24 of the United States, including Washington DC, two Canadian Provinces, two Mexican states, as well as in Japan, England, Spain, Wales, France, Austria, India, Brazil, Germany, Sweden and now Italy.

For more information on ASM awards and honors, contact Ms. Wendy Taylor, ASM International, Materials Park, OH 44073-0002. Phone: (216) 338-5151, ext. 614. Fax: (216) 338-4634.

First Electric Furnace

The Electric Arc Furnace, located at The Museum of Science and Technology in Milan, Italy, was recently honored as an ASM Historical Landmark. The honor recognizes the site where some of the most significant advances in the materials field occurred, as well as the major contributions of hundreds of talented and dedicated scientists, engineers and technicians.

The Museum of Science and Technology houses the first commercial electric arc furnace, created by Italian engineer Ernesto Stassano. His innovation marked the beginning of a new industry — electric steel making — which was used throughout the world. In 1898, Stassano designed the furnace to use the principle of an indirect arc; i.e., a vertical, cylindrical shell with three electrodes spaced 120 degrees apart and entering the furnace just above the bath. A Frenchman, Pichon, first proposed this idea in 1853, but Stassano brought this process to reality.

After continued improvement to his process, Stassano founded an electric steel foundry in Turin in 1904. Production began with two one-ton furnaces, two two-ton furnaces and one five-ton furnace. By 1907, Stassano's furnaces were operating in Germany and Austria for the production of special steels and for steel casting starting from scrap. The first Stassano furnace in the United States was installed in 1913 at Warman Steel Casting Co., Redondo, CA.

The Electric Arc Furnace was nominated for an ASM Historical Landmark by Armond Di Guilio, an ASM Life Member and member since 1929. The inscription on the Historical Landmark plaque, presented to The Museum of Science and Technology for the Electric Arc Furnace by ASM, details the developments made by Stassano. The plaque reads: "The first electric furnace of the indirect-arc type for melting steel was invented by Ing. Ernesto Stassano in 1898. Furnaces of this type were used to produce industrial quantities of steel in Europe and America."

Mound Laboratory

ASM International recently awarded Mound Laboratory, located in Miamisburg, Ohio, as an ASM Historical Landmark. This honor recognizes the site where some of the most significant advances in the field of materials occurred, as well as the major contributions of talented and dedicated personnel who worked there over the years.

Currently operated by EG&G Mound Applied Technologies under a contract from the US. Department of Energy, the laboratory began as a technical organization in Dayton, Ohio, in 1943, when the Monsanto Chemical Company accepted responsibility for determining the chemical and metallurgical properties of polonium for the Manhattan Engineering District. These efforts, instrumental to the atomic bomb construction, later became known as the Dayton Project. By 1946, a permanent polonium production facility was needed. The site selected was adjacent to the site of the largest conical ancient Indian Mound in Ohio, hence Mound Laboratory.

During the late 1960's, Mound changed its focus from nuclear materials to space technology. Researchers developed radioactive heat sources which, coupled with thermoelectric converters, produce electric power. These power generators were vital to the success of the Apollo space program. More recently, Mound's Radioisotopic Thermoelectric Generators (RTGs) have powered various space satellites including Pioneer, Viking, Voyager, Galileo, and Ulysses deep-space probes. A generator is currently being developed for the 1997 Cassini space-probe mission.

In addition to its nuclear material and space technology work, Mound's applied materials capabilities are very diverse. Over the years, the facility has provided many specialized supporting technologies. Some of these include glass to metal sealing, thermite processing, surface science analysis, unmachinable materials, and zero-valent metals in glass.

Mound Laboratory was nominated for the distinction by Patrick Schleitweiler, 60-Watt Heat Source program manager, EG&G Mound Applied Technologies and chairman of the ASM Dayton Chapter. Dr. Linda L. Horton, manager, Basic Energy Sciences Program, Metals and Ceramics Division, Oak Ridge National Laboratory and ASM Trustee, gave a history of the facility, then presented the Historical Landmark plaque to Mr. Larry Kirkman, area manager for the Miamisburg Area Office, US Department of Energy. The plaque reads: "Mound Laboratory's pioneering efforts in applied materials research and development successfully supported the Manhattan Project and provided radioisotope thermoelectric generators for space exploration."

News For Students

Resume Database System

ASM International has expanded its resume database service to include students. The service, managed by Career Access, allows ASM's student members to submit their resume to the database without charge.

Thom Passek, assistant director of Chapters and Membership, said the service was recently extended to include students "because we felt that we should provide 'one central service' in helping members gain employment whether they are experienced professionals or students. Also, the previous service that was offered to student members, through another organization, charged students $20 to have their resumes listed. This program offers the service at no cost to all ASM student members."

Companies can access the system, for a charge, using a search form. The names of the students matching the requests are sent to the employer within 48 hours. The company then contacts the prospective candidates for an interview. According to Jeff Wolf, president of Career Access, an average of 10 prospective employees are matched for each search. The database is open to all fields ranging from manufacturing to aerospace to government agencies. Wolf said most of the positions are for full-time employment, but the service can be used to find co-op or internship positions.

Student files are kept in the database until September of each year. Students can be entered into the database by completing and returning a standard form from Career Access. In order to allow employers to receive consistent information on each of the candidates, prepared resumes are not accepted. Wolf recommends applicants "try to be as precise as possible [when filling out the form], yet give a respectable summary of the work you've done."

Forms for employers and students can be requested from Career Access; PO Box 296, 3972 Brown Park Drive, Suite C, Hilliard, Ohio 43026 or call (614) 529-0429. For more information on ASM's student chapters and membership, contact ASM Member Services Center, Materials Park, Ohio 44073. Phone: (216) 338-5151. Fax: (216) 338-4634.

ITSA Urges International Students to Apply for Scholarships

The scholarship program, initiated in 1991, recognizes excellence in thermal spray research from students who demonstrate financial need; have at least one year of studies remaining; are recommended by a professor and industrial sponsor and have at least a 3.0 grade point average (on a scale of 4.0). The ITSA has just expanded the program and invites participation from thermal spray students in all countries for next years scholarships. Previously the program gave two scholarships to students studying only in North America.

The International Thermal Spray Association (ITSA) has awarded its annual scholarships to three students conducting research in thermal spray technology. Jeffrey Brogan and Srikanth Reddy, both of State University of New York, Stony Brook, NY, and Timothy Hussey of Drexel University, Philadelphia, PA, each received $1,500.

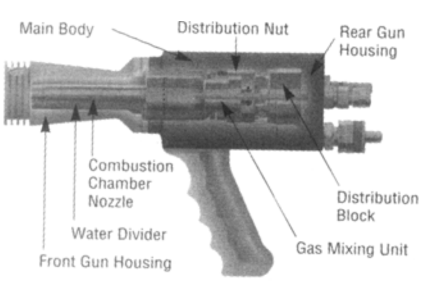
Mr. Brogan is currently investigating the spraying characteristics of polymers for his Ph.D. He will study how the combustion spray process affects the properties of the polymeric deposit. He plans to conduct a microstructural study correlated with experimental data that will permit the building of an empirical model. Mr. Brogan will pursue his research after graduating, developing a better understanding of polymers and polymer matrix composites for a wide use of applications. Mr. Reddy, also a Ph.D. student, is researching the processing of sol-gels and other non-traditional starting materials using the Electro-Magnetically Coalesced (EMC) plasma process. He will be studying the chemical formation and melting of materials in a plasma flame. He is preparing for a career designing new thermal spray equipment and improved methods of analyzing coatings. Mr. Hussey, who is pursuing his M.S. in materials engineering, is researching the synthesis and consolidation of high temperature structural materials using vacuum plasma spraying - a project funded by the Office of Naval Research. The project's objective is to deposit a near full density material which will react to form an intermetallic matrix composite. After graduation, Mr. Hussey wants to work as a research engineer, developing new thermal spray products and markets.

For information on applying for these scholarships, contact Chairman Albert Kay, ASB Industries, 1031 Lambert Street, Barberton, OH 44203-1689, U.S.A. Fax: (216) 753-7550.

Products and Equipment

HVOF Equipment From Miller Thermal, Inc.

The Miller Thermal Model 3400 control console provides automatic operation of HVOF spraying. The unit is designed for use with the Miller Thermal HV-2000, a water-cooled production spraying HVOF gun. It can be used with the Model 3202 Water Booster Pump, or Model 3252 or 3260 Heat Exchangers. The console can perform completely automatic production spray cycles when using a Miller MR-2000 robot or gun manipulator.



Cross-section View

Features of the system include programmable controller for sequencing operation, multiple fuel gas capacity and complete control over gas flows from front panel

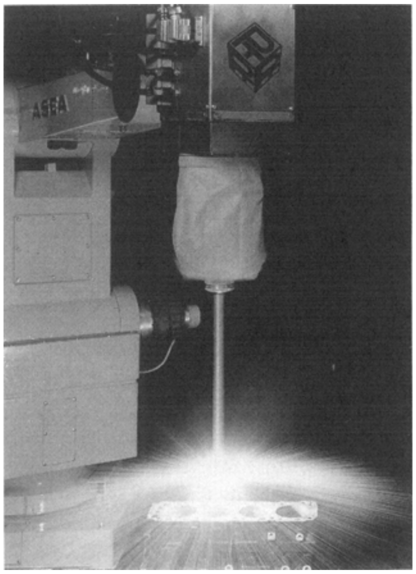
Fuel gas, oxygen, powder transport gas and powder enter the gun centrally and axially to the combustion chamber and water cooled expansion nozzle. This design provides unrestricted gas and powder flow. The premachined front gun housing readily accepts an optional Remote Auto Ignite/Sense unit. This unit uses a glow-plug to light the gun and a photo-diode sensor to detect the presence of the flame. If a flame is not detected, the Auto Ignite/Sense unit shuts down the console. Anodized exterior parts protect the gun from wear, and quick disconnect flashback arrestors on hoses provide fast assembly and disassembly operations. The HV-2000 requires 8 US gal./min of water at 175 PSI and weighs 7.3 lbs (3.3 kg).

Applications for HVOF coatings are growing steadily. HVOF is the process of choice for applying ceramic and carbide coatings for aerospace applications; rotating shafts in pumps and compressors, valve and seals, rolls in paper/pulp mills; and for corrosion/wear resistance in the chemical industry. The HVOF process results in coating densities and adhesion significantly better than those of plasma sprayed coatings. Wear resistant coatings such as WC/Co typically obtain tensile bond strengths in excess of 83 MPa (12,000 lb/in.^{2}), "as-sprayed" densities of 99%, and microhardnesses of 1500 VHN_{300}.

Contact: Miller Thermal, Inc., N670 Communication Dr., PO Box 1081, Appleton, WI 54912. Phone: (414) 734-9292, Fax: (414) 734-2160.

Innovative Plasma Spray Technique

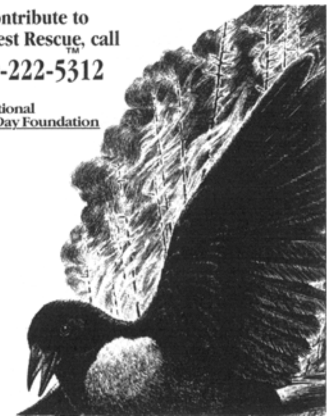
With the new RotaPlasma®, a plasma spray gun holder, it is now feasible to coat the inner surfaces of very heavy



The newly developed RotaPlasma® spray gun during the coating of the cylinder bores of an engine block in a fixed position.

components or of components in a fixed position. The spray gun developed by Plasma-Technik Ltd., a member of the Sulzer Corporation, is suitable for the coating of internal surfaces of up to 35 mm in diameter and up to 500 mm in length, as are found in engine cylinder blocks, pump housings, flanges, tubes, etc. The head of the spray gun is rotated at a speed of up to 200 times per minute and for the coating of inner radii can be inclined at angles up to 90°. Its turning circle can also be varied to cope with different needs. The first RotaPlasma® spray guns are now operating successfully.

Contact: Sulzer Plasma Technik, Inc., 1972 Meijer Drive, Troy, MI 48084, USA. Phone: (313) 288-1200, Fax: (313) 288-4162.



Company News

Miller Thermal Incorporated

Miller Thermal Incorporated manufactures a complete line of electric arc, plasma, and HVOF spray equipment. Miller Thermal can be a single-source for all the equipment and consumables needed to construct and supply any type of thermal spray system.

Handling Equipment Miller Thermal can provide the handling and peripheral equipment to equip any installation, from basic thermal spray shops to high production, advanced technology thermal spray cells. Miller Thermal also offers a full line of spray booths and air extraction units.

Alloys International Division Increasingly stringent coating specifications require continuous research and development of powder manufacturing methods that will ensure consistent coating quality and optimal system operation. The Alloys International Division of Miller Thermal, located in Baytown, Texas, manufactures a broad range of powders for the thermal spray industry. Alloys recently completed an expansion to include facilities for the production of ceramic powders. Powders for special coating applications and dimensional restoration, as well as cast carbide and sintered inserts, are also available. Research and development into powders meeting distinctive proprietary specifications can be done on request by Alloys International with complete confidentiality.

Research and Development The research and development initiative at Miller Thermal has resulted in cooperative agreements with leading manufacturers and research organizations. These agreements have led to the production of Miller Thermal's Model 4500 Computerized Plasma Console, an advanced plasma system console.

Contact: Miller Thermal, Inc., N670 Communication Drive, PO Box 1081, Appleton, Wisconsin, 54912. Phone: (414) 734-9292, Fax: (414) 734-2160.

Metcut Research Associates Inc.

Metcut Research Associates Inc. is an independent applied research, development and testing organization offering expertise and laboratory facilities in the field of materials engineering. The Company is an ESOP-based employee-owned corporation, founded in Cincinnati as a partnership in 1948, and incorporated under the laws of Ohio since 1958.

Materials engineering at Metcut focuses on both metallic and non-metallic structural materials. Experimental work is carried out in three laboratories. One is concerned with the microscopic inspection, failure analysis and quality assurance aspects of materials and thermally applied coatings. The other two are responsible for the mechanical testing of specimens, components and assemblies under static and dynamic conditions. A machine shop dedicated almost exclusively to the manufacture of test specimens operates as an integral part of the materials engineering facilities.

Metcut operates in 45,000 square feet of Company-owned property in Cincinnati. The testing operations serve an international market covering all of the US plus several customers in Europe and Asia. The basic field is high temperature metallurgy applicable to turbine engines and power generation equipment. This work inherently involves difficult-to-machine materials, hence reinforces the need for an integral specimen manufacturing operation to support the effort. While the core activity stems from high temperature metallurgy, it has spread to involvement with a variety of other metallic as well as non-metallic materials having a broader application base.

Metcut services over 2,500 companies world-wide. A wholly owned satellite facility, of approximately 11,000 square feet, Metcut Recherches S.A. has recently been opened in Carquefou, a suburb of Nantes in western France. This laboratory will service the growing market within the European community.

Major customers of Metcut include Allison Gas Turbine Div., GMC; Chromalloy Research & Technology; Department of the Air Force; Fortech - Division Airforge (France); Garrett Engine Division; GE Aircraft Engines; Inco Alloys International; Ladish Company; Mar-Test, Inc.; Pratt & Whitney; Rocketdyne Division; SNECMA (France); Techspace Aero (FN Moteurs S.A., Belgium); Textron Lycoming Inc. (incl. Bell Helicopter); and Wyman-Gordon Company. Metcut has supplied general materials engineering services principally in the form of specimen manufacturing, testing and metallographic laboratory evaluations to these customers.

Contact: Metcut Research Associates, Inc., 3980 Rosslyn Drive, Cincinnati, OH 45209-1196. Phone: (513) 271-5100, Fax: (513) 271-9511.

The Central Coatings Laboratory (CCL) Program

The CCL Program at Metcut provides a framework and central location for training and total communication on coating systems evaluation. This concept has been developed to promote more effective communication and transfer of data in the evaluation of coating systems. Standardization of evaluation techniques and training on new developments to the coatings community can be difficult. Specification requirements vary according to the system and part number. The CCL Program emphasizes three major areas: Training (Level 1 - Metallographic Preparation/Mechanical Testing, Level II-Metallographic Interpretation); Communications Network; and Round Robin Testing.

Training The communication of standardized metallographic preparation and mechanical testing techniques occurs in Level I training with extensive hands-on experience. Level II is entirely devoted to metallographic interpretation with emphasis on understanding and comparison to industry specifications. A comprehensive facility has been developed at Metcut with a variety of metallographic preparation/interpretation equipment from LECO, Struers, and Buehler.

Communications Network is a computer-based system driven and designed by the coatings community. It is a vehicle to accumulate and share pertinent industry data in a meaningful form which benefits all those in the coatings industry. Industry specifications are available at a central location, via phone line modem into a bulletin board. The bulletin board will alert vendors of generic problems with specific coatings, major changes in specifications, new evaluation methods, etc. Feedback on possible customized courses, CCL performance, etc., will also be solicited.

Entrance to the Communications Network is via a company/personnel password. The system is MS-DOS based but accessible via a variety of hardware/software combinations. The network is available on a 24-hour basis with workday updates as data input progresses. Phone numbers and other pertinent data are provided as company representatives begin training.

Round Robin Testing This testing evaluates the lessons learned by the trainees in both Level I and II courses. Dependent upon specification/coating system requirements, various tests must be performed for approval. An equal number of samples will be prepared by both the vendor and CCL for comparison. Written evaluation procedures will be reviewed for approval.

Contact: Metcut Research Associates, Inc., 3980 Rosslyn Drive, Cincinnati, OH 45209-1196. Phone: (513) 271-5100, Fax: (513) 271-9511.

A Newly Invented Powder

S. Rangaswamy
Sulzer, Plasma Technik
1972 Meijer Drive
Troy, MI 48084
USA.

Functional surfaces are now an integral part of modern metallurgy and numerous branches of industry. A significant number of these demanding applications require the use of composite materials. In their production, alloy powders and other expensive, rare and difficult to obtain metals and non-metals are processed into hybrid materials. Composites exhibit unique properties that the individual components cannot accomplish themselves. Users and producers, however, are still not satisfied because many powders as well as their production are still associated with shortcomings. A remedy is brought about by a new mechanical process that might revolutionize the production of powders. It clads core material particles without the addition of binder materials.

More Versatile And Cheaper

With this innovative technology, composite powders can be produced substantially cheaper than with conventional processes. In addition, the almost unlimited possibilities of combination widen the range of powder applications. A number of the new composites have passed extensive laboratory tests and are now undergoing final field testing in the aircraft, automobile and steel industries, as well as in a rubber plant.

Restrictions Challenge Imagination

Nowadays, the majority of powders are produced by means of expensive chemical precipitation, high-temperature sintering processes or with the use of organic binders. Powders produced by these processes are limited in their applications due to the expensive processing costs or the deleterious presence of organic or inorganic binders. The presence of binders also limits the use of such composite materials in deposition processes such as vacuum processing, high velocity spraying, laser cladding and plasma transferred arc. The need for the disposal of chemicals and solvents as well as other environmental control requirements pose additional difficulties for the processing of such powders. Most important, however, is the fact that the development of composite-powdered materials for new applications is severely restricted by the narrow choices of the powder-manufacturing route and by limitations in the selection of individual components.

Table 1 Potential applications for the new attrition mill technology.

Applications	Coated Components	Core Material	Secondary Material
Medical	Surgical implants	Titanium	Hydroxyapatite
Aircraft industry (jet engines)	Blade tipping, diffusion barrier coatings	Metal alloys	Ceramics
	Overlay coatings for high temperature corrosion	Metal	Oxides (vacuum plasma spraying)
Automobiles, ships (internal combustion)	Cylinder liners, piston rings	Metal alloys	Solid lubricant composites
	Bond coats for TBC	Metals, alloys	Ceramics
Pulp and paper industry	Yankee dryer	Metal	Metal refractory alloys
Mechanical engineering (boilers)	Boiler components (e.g., water tubes, superheaters)	Metal	Ceramics
Steel mills (rolling trains)	Annealing rolls, galvanizing rolls	Metal	Ceramics
Rubber industry	Extension rolls, shear plates	Metal	Ceramics

Table 2 Comparison of the various powder manufacturing processes.

Characteristics	Processes using Binders	Chemical Precipitation	Spray Drying	The New Attrition Mill Process
Capable of producing composite powders	yes	only Ni and Co	yes	yes
Binders	yes	none	yes	none
Yield	60-80%	50%	50%	>90%
Chemical disposal	yes	yes	yes	none
Processing costs	medium	very high	medium	low
Energy costs	low	high	low	low
Capital expenditure	low	very high	high	low

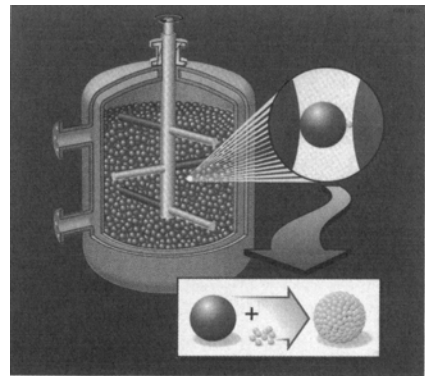


Fig 1. The manufacture of composites in an attrition mill facilitates numerous new applications. The process anchors standard particles in a core material with, for example, the aid of steel balls.

These restrictions spurred the development of the new technology at Sulzer Plasma Technik, Inc., Troy, Michigan (USA), where powder components are mechanically bound to composites. The improving secondary and tertiary components are embedded in the surface of core particles. This completely dry running process does not necessitate any special precautions and, using commercially available equipment, operates in an environmentally friendly manner.

With the patented process, which is now in the test phase, the particles are not reduced appreciably in size and it therefore results in a high yield. This new process lends itself to the manufacture of a variety of composites using metals and alloys as core materials and carbides, ceramics, oxides, and plastics as secondary materials (Table 1). Although invented primarily for the production of powders for thermal spraying applications, this process can be utilized in the powder-metallurgical fabrication of parts such as injection moulding, metal matrix composites, and the like. It is to be expected that the above named powders will be able to be employed in almost any industry where powdered materials are in use.

How It Is Accomplished

The components of the powder to be manufactured are filled in an attrition mill containing a milling media; e.g., steel balls. An agitating spindle operating at high speed causes the balls to collide (Fig. 1). In accordance with the laws of probability and as a result of the direct compression and collision, the secondary particles trapped between the balls are embedded from all directions in the likewise trapped core particles. The result is coated particles.

Examples

Up to now, composite powders for application in various industries have been produced with the new technology and undergone extensive testing in customers' laboratories (Table 2). In the majority of cases, the following applications are being evaluated in field tests.

- Steel mills: Composites of CoNi-CrAlY-10%Al_2O_3 and CoCrMoSi-10%Al_2O_3, applied by means of the high-velocity thermal sprayed coating process (HVOF), have undergone successful laboratory tests for high-temperature wear at 1150 °C. These products are undergoing field testing in steel mill applications.
- Aircraft industry: Plasma-sprayed abradable seal coatings of an AlSi-15% BN composite have successfully undergone laboratory tests at 510 °C and are now operating in the gas turbine engines of aircraft.
- Plasma-sprayed coatings of CoNiCrAlY-15% BN composites for sealings and abradable seals are being evaluated at temperatures of 540 to 815 °C in jet engines.
- An abradable seal of yttria stabilized zirconia + polyester + BN composite successfully endured temperatures up to 1200 °C in laboratory tests.
- Automobile industry: A plasma-sprayed composite of corrosion-resistant steel and Al-CaF_2 is currently undergoing tests. It could replace cylinder liners in aluminum engine blocks. Piston rings have been coated with a composite of molybdenum-nickel base for anti-wear protection. It results in a coating of high homogeneity from which the individual components do not separate.

Contact: Sulzer Plasma Technik, Inc., Subramaniam Rangaswamy, 1972 Meijer Drive, Troy, MI 48084, USA. Phone: (313) 288-1200, Fax: (313) 288-4162.
(Reprinted from Technical Review Sulzer 2/94, pp. 6-8.)

JOURNAL OF

THERMAL SPRAY

TECHNOLOGY

An ASM Publication

Published by
ASM International®
Materials Park, Ohio 44073-0002
Tel: 216/338-5151
Fax: 216/338-4634

Publisher
William W. Scott, Jr.

Managing Editor
Mary Anne Fleming

Advertising Manager
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Production Coordinator
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