Thermal Spray Technology

April 30 – May 2, 2010, 8:00 – 17:00
Location: Fairmont Singapore, Room Clark

Instructor:
Christopher C. Berndt, PhD, FASM, HoF
Professor, Swinburne University of Technology
Melbourne, Australia

Course Overview:
Thermal spray technology and coatings solve critical problems in demanding environments. They provide “solutions” to problems involving repair, wear, high temperature and aqueous corrosion, and thermal protection. Thermal spray can also be used to manufacture net-shapes, advanced sensors and materials for the biomedical and energy/environmental sectors. These and other emerging applications take advantage of the rapid and cost-effective capabilities of thermal spray technology in the OEM and repair industries. Thermal spray processes - twin wire-arc, combustion, high velocity oxy-fuel (HVOF), cold spray and plasma spray, and associated technologies, can deposit virtually any material as a surface coating onto a wide range of other materials. Coating reliability and effectiveness requires that these overlay coatings be selected, engineered and applied correctly. This course (i) provides a thorough grounding and understanding of thermal spray processes, (ii) presents the complex scientific concepts in terms of simple physical models, and (iii) integrates this knowledge to practical applications and accepted thermal spray practices. NO mathematics is used to explain the processes or materials/mechanical engineering. Participants are encouraged to contact the instructor prior to the course so that any particular application or problem can be discussed as a case history. Each registrant receives the Handbook of Thermal Spray Technology and a comprehension set of notes that include the presentation slides.

Learning Objectives:
Upon completion of this course, participants will:

• Determine the historical basis for thermal spray technology and have detailed knowledge regarding the development of equipment and materials as related to present-day technology
• Recognize the terminology, principles and underlying theory of thermal spray technology
• Explain how feedstocks are designed and manufactured and how to select them for different spray processes
• Identify applicable testing methods and currently accepted industrial practices used for quality control of coatings

Who Should Enroll:
• Technologists
• Engineers
• Technicians
• Technical marketing personnel
• Graduate students and other professionals entering the thermal spray field or who wish to update their knowledge

Course Outline:
1. Surface Science
2. Equipment & Theory
3. Processing & Design
4. Materials
5. Applications
6. Testing & Characterization

About the Instructor:
Chris Berndt earned his Ph.D. from Monash University, Melbourne in the area of “The Adhesion of Flame and Plasma Sprayed Coatings.” See <http://www.swinburne.edu.au/feis/iris/staff/cberndt.html> He took on several post-doc fellowships in the U.S. before returning to Monash, where he rose to the rank of Senior Lecturer in Materials Engineering before joining the faculty at Stony Brook University, where he was appointed Associate Dean for Undergraduate Studies in 2001. He is also qualified as an ABET visitor for materials and engineering science programs. Berndt remains an Adjunct Professor at Stony Brook.

In 2005, Berndt returned to Australia as the founding Professor of Surface and Interface Engineering at James Cook University, Queensland. He moved to Swinburne University of Technology, Melbourne in 2008 as the founding Professor of Surface Science and Interface Engineering. He also serves as Director of the Industrial Research Institute Swinburne (aka ‘IRIS’). Berndt has served as President of the ASM Thermal Spray Society and as an ASM Trustee, and he was inducted into the Thermal Spray Hall of Fame in 2007. He has more than 350 publications in the field of materials science and engineering, and has served as editor for 10 conference proceedings on thermal spray.

Registration Fees:

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To register for the courses or for any questions, please contact ASM Member Service Center at memberservicecenter@asminternational.org
(Product Code: 253081410)
Education Courses

Understanding and Improving your Thermal Spray Processes

May 1 – 2, 2010, 08:00 – 18:30
Location: Fairmont Singapore, Room Ord

Instructors:
Dr. Maher Boulos, TS-HoF
Professor, University of Sherbrooke
Sherbrooke, Canada

Dr. Pierre Fauchais, FASM, TS-HoF
Professor, University of Limoges
Limoges, France

Dr. Joachim Heberlein, FASM, TS-HoF
Professor, University of Minnesota
Minneapolis, United States of America

Course Overview:
Thermal spray coatings are receiving increased attention as solutions to corrosion, wear and materials compatibility problems. Thermal spray processes using electric arcs, combustion and plasma spray can apply almost any material to the surface of another. These coatings must be correctly engineered and applied to operate as an overlay surface. Education is vital to understanding coating systems and improving thermal spray coating reliability. This 2-day course will review the processing science of a wide range of thermal spray coating processes. The theory of operation and practice of the coatings will be presented, including thermal spray process control, coating application, characterization and testing. Practical coating systems for electric arc, combustion and plasma spray will be reviewed using case studies.

Learning Objectives:
Upon completion of this course, participants should be able to:

- Summarize thermal spray processing science, applications and practice
- Describe how thermal spray processing interacts with the materials it is designed to protect
- Perform a techno-economic comparison of different technologies

Who Should Enroll:
This course is designed for process, application, development and design engineers, researchers and quality-control personnel. It will also be helpful for anyone involved in specifying materials, materials suppliers, sales representatives and technical management.

Course Outline:
1. Introduction and Course Objectives
2. Overview of Thermal Spray Techniques
3. Flame Spraying Systems
4. Cold Spray
5. Characteristics of the Plasma State
6. Plasma Spraying I - D.C. Plasma Spraying
7. Plasma Spraying II - R.F. Induction Plasma Spraying
8. Wire-Arc Spraying
9. Plasma Transferred Arc
10. Plasma/Particle Interactions
11. Process Diagnostics
12. Powder Production for Thermal Spraying
13. Surface Preparation
14. Deposit Formation and Coating Properties
15. Thermal Spray Process Controls
16. Industrial Applications of Plasma Spray
17. Summary, Conclusions and Discussion

Instruction Language: All instruction from this course and all course materials will be in English.

Registration Fees:

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Gas Turbines Metallurgy, Coatings and Repair Technology

May 2, 2010, 08:00 – 18:00
Location: Fairmont Singapore, Room Blundell

Instructors:
Jeffery S. Smith
President and Principal Metallurgical Consultant
Material Processing Technology, LLC
Norton Shores, United States of America
JeffSmith@mpt-llc.com

Eng. P. Nagy Douglas
Manager, Turbine Component Repairs
Liburdi Turbine Services
Dundas, Canada
dnagy@liburdi.com

Course Overview:
This workshop will discuss the development history, manufacturing processes, application and refurbishment of the high temperature materials and coatings used in gas turbine engines with particular emphasis on hot section superalloy component manufacture and refurbishment. The metallurgy of nickel and cobalt based superalloys will be discussed and the many steps involved in investment casting manufacture, from wax pattern & ceramic core production, shell build, equiaxed, DS or single crystal vacuum casting and post cast operations will be reviewed. This will include review of advances in cooling configurations, casting imperfections, inspection methods and general acceptance criteria. Specific challenges related to making large F, G & H-class components and sophisticated air cooled, single crystal aero-engine airfoils will be noted. The widespread use of thermal barrier coatings has brought great focus to the issue of coating selection. The various types of gas turbine hot section coatings, their selection criteria and manufacturing method used will be discussed. The benefits of repair and refurbishment of engine run parts is well established. The increased complexity and high replacement cost of hot section components has placed greater importance on development of innovative component repair schemes. Participants will learn methods of assessing component damage experienced from service exposure, typical degradation modes observed and the techniques used to analyze the remaining life of components removed from service. The various component repair technologies utilized to restore components will be discussed in detail (ie dimensional checks, coating removal techniques, HIP and rejuvenation heat treatments, weld repair, diffusion brazing processes and component re-coating) as will quality assurance methods and procedures to verify the refurbished components meet industry standards. The workshop includes many case study examples of component refurbishment and the last section is devoted to a workshop where attendees develop component repair solutions. Participants are encouraged to submit questions in advance regarding repair issues faced in their jobs.

Learning Objectives:
After completing the course the participants should be able to explain:
- What makes superalloys especially suited for gas turbine components
- Understanding of the distinction between conventional casting and directional solidification
- How different damage mechanisms (oxidation, corrosion, erosion) affect the component
- Advantages & disadvantages of the many types of protective coatings
- How high cycle fatigue & low cycle fatigue damage is caused, prevented, and repaired
- Various heat treatments used in repairs, and why they are important
- Critical quality control steps in component manufacture and repair
- How to reliably extend the service life of valuable components

Who Should Enroll:
Typically technical staff, engineers and technicians responsible for various aspects of gas turbine design, upgrade, manufacture, repair, analysis, operations, or maintenance will attend. A must for GT repair shop personnel, insurance companies, coatings suppliers, GT OEM designers and technical staff.

Course Outline:
1. Gas Turbine Overview
   - Gas Turbine Engine Designs
   - Typical Gas Turbine Components, Materials and Coatings
   - Gas Turbine Airfoil Materials, Coatings and Airfoil Design Trends

2. Materials and Metallurgy
   - Superalloy Metallurgy
   - Evolution of Superalloy Materials Technology
   - Production of Superalloys
   - Investment Casting of Equiax, DS and Single Crystal Airfoils
   - NDT Inspection, Criteria and Acceptance Standards

Education Courses
Education Courses

Gas Turbines Metallurgy, Coatings and Repair Technology

3. Gas Turbine Coatings
   - Superalloy Surface Stability
   - Comparison of Oxidation/Corrosion protection
   - Manufacturing Methods and Requirements
   - Diffusion vs. Overlay Coatings
   - Thermal Barrier Coatings

4. Degradation of Gas Turbine Components
   - Metallurgical Effects of Service
   - Creep
   - High Cycle Fatigue
   - Low Cycle Fatigue
   - Environmental Degradation

5. Why repair and refurbish parts?
   - Cost Benefit of Repairs
   - Repair Market Trends
   - The Future for Industrial Frame GT Repairs

6. Component Evaluation: The evaluation of used components and determination of the repair/refurbishment process will be discussed
   - Timing and selection of components for analysis
   - Micro structural analysis
   - Mechanical testing stress rupture bars
   - Coating Evaluation
   - Hot Corrosion Attack
   - Failure Analysis
   - Component Management Program
   - Determine Damage Mechanisms, the Extent of Damage, Root Cause of Damage, and Corrective/Preventive Action

7. Refurbishment & Repair Processes: Procedures and techniques used to restore components to industry
   - Standards
   - Typical Damage
   - Coating Stripping
   - Dimensional Checks
   - Re-Coating Selection and Processes
   - HIP and Rejuvenation Heat Treatments
   - Superalloy Weld Processes
   - Diffusion Brazing

8. Quality Assurance: Methods and procedures to verify components meet industry standards
   - QA Certification
   - Quality Plan
   - QA Inspections
   - NDE Defect Criteria
   - Dimensional Specification
   - NDE Inspections

9. Case Studies & Problem Solving
   - Case studies presented by the instructors to illustrate the process of component repair & refurbishment. The class will then be divided into teams and given components for which they will determine the best process

10. Round Table Discussion
    - Round table discussion regarding the latest repair trends and student questions

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Product code (251481510)
The Metallographic Preparation and Evaluation of Thermal Spray Coatings

May 6, 2010, 08:00 – 16:30
Location: Struers Lab, Singapore Branch

Instructor:
Douglas G. Puerta
Laboratory Director
IMR KHA - Portland
Portland,
United States of America

Course Overview:
While there are many methods commonly used to evaluate thermal spray coatings, the metallographic cross-section generally provides the greatest amount of information. From a metallography sample, information can be obtained about the type of coating, the integrity of the coating, the application method, and the adhesive/cohesive properties of the coating and substrate. However, in order to perform a meaningful evaluation of thermal spray coating, proper metallographic preparation is essential. Poor metallography can lead to false conclusions about coating integrity and/or spray booth parameters. Worse yet, a faulty evaluation can lead to bad parts “escaping” into service.

This class covers a wide range of topics relating to the preparation and evaluation of thermal spray coatings. Emphasis is placed on teaching the student to understand the role that different types of equipment, consumables, and preparation recipes play in revealing a true coating structure. This is accomplished through a mixture of classroom and laboratory instruction.

The laboratory portion of this class will allow students to operate equipment commonly found in a modern metallography laboratory. Samples from various coating families (ceramics, hardcoats, abradables, metallics) will be prepared and analyzed. The effects of changes in consumables and preparation recipes will be observed in actual thermal spray coating samples.

Learning Objectives:
This course will focus on the following key topics:
• Specific issues pertaining to thermal spray coatings that must be addressed during the four stages of metallographic preparation (sectioning, mounting, grinding, and polishing)
• The role that consumables and preparation recipes play in creating a representative coating structure
• Understanding the tools and methods necessary to differentiate between those features in a coating that are inherent, versus those which have been induced during metallographic preparation

The Learning Objectives will be met through a mixture of classroom lecture and laboratory time. As part of this course will take place in a metallography lab, the students will have the ability to compare and contrast different methods of preparing coatings.

Who Should Enroll:
This course is designed for anyone involved in either the processing or evaluation of thermal spray coatings.

Course Outline:
1. Use of Coatings for Applications in the Aerospace, Medical Device, Automotive, and Micro Electronic Industries
2. Metallography Overview
3. Sectioning
4. Hot and Cold Mounting
5. Grinding
6. Polishing I – Selection of fine grinding and polishing consumables
7. Polishing II – Recipes and coating families
8. Metallographic Standards
10. Evaluation of Coatings II – Issues specific to the main coating families

Registration Fees: Before After
April 15, 2010 April 15, 2010
Member Fee: 575 US Dollars 625 US Dollars
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ASM Member Fee: 625 US Dollars 675 US Dollars
Non-Member Fee: 725 US Dollars 775 US Dollars
Student Fee: 200 US Dollars 250 US Dollars

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