ASM Pune Chapter
The Materials Information Society
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ASM International, Pune Chapter

Chapter News Letter

Office Bearers

B. R. Galgali	Dr. Sanjay Arole	Rahul Gupta	Y. S. Gowaikar
Chairman	*Vice Chairman*	*Secretary*	*Treasurer*

Issue No. : 10 | Editor - Louis Vaz | Chairman, News Letter Committee - Louis F Vaz | November 2013

EDITORIAL...

Diwali Greetings and Welcome to the November 2013 edition of the Newsletter.

We celebrated the Annual Day on the 10th of August 2013 and our Chief Guest was Mr.H.M.Mehta.

Mr . L.D.Deshpande received the Chapter Sustaining Award

We conducted technical sessions on the following :

- Role of Energy Efficient and Reliable Equipment in the Global Scenario
- Innovative Technology in Atmospheric Batch Integral Quench Line
- Design of Experiment

A technical paper on Functionally Graded Materials by Ms.Priyanka Deo and Ms.Kirti Petkar of Cummins College of Engineering for Women, Pune is included in this issue.

Mr. Sushil Verma, Chief Executive Officer, Aichelin Unitherm Heat Treatment Systems India Pvt. Ltd., Talegaon is featured in our Know our Member section.

Your contribution matters much to this newsletter. Please send us technical articles and your profile for inclusion in the Newsletter. We welcome your suggestions to make this news letter more useful & informative to you. Please feel free to write to me at loufvaz@hotmail.com .

Regards,

Louis Vaz
Editor

Annual Day of ASM INTERNATIONAL - Pune Chapter

Mr . L.D.Deshpande receiving the Chapter Sustaining Award

Chief Guest Dr.H.M. Mehta being felicitated by Mr. C.Dias

The Annual Day was held at Pune Club on 10th August 2013.

Dr.H.M.Mehta was the chief Guest. Dr. Mehta spoke at length on how ASM International came to India and how it was taken forward to form many Chapters in India.

New sustaining members were felicitated and presented with the chapter sustaining member memento.

Awards were given to student volunteers, supporting organizations /individuals & outstanding committees. Chapter News Letter for the quarter was released.

Chairman, Mr. B.R. Galgali's Address

Dr. Satyam Sahay being presented a momento

Mr. S.Phansalkar receiving a momento

A section of the audience

Vote of Thanks by Mr. Udayan Pathak

Innovative Technology in Atmospheric Batch Integral Quench Line

Dr.Marco Marchetti lighting the Lamp

Mr.B.R. Galgali & Dr.S. Arole lighting the lamp

Mr. Francesco Pieropan addressing the delegates

A technical presentation on Innovative Technology in Atmospheric Batch Integral Quench Line was held at Hotel Pride on 3rd September 2013. By Tanmoy Kumar Sarkar, Country Head (India Business Operations), CIEFFE Fornie Industriali SRL, Indian Branch Kolkata. Dr Marco Marchetti CIFFE group owner was the Chief Guest.

The presentation focused on - How standardized batch integral quench furnace lines have been realized very flexible, man-less automatic and high efficiency production lines saving energy, reducing buffer times , attributing the top class quality with Innovative technologies offered by CIEFFE. CIEFFE's perception in application engineering for value addition to the cost, end product process and quality. How evolution has been made in furnace construction, drive mechanism, heating systems, insulation methods and application of various process steps.

Mr. Tanmoy Sarkar addressing the audience

Forthcoming Events

The following Technical talks are expected to be conducted by ASM International, Pune Chapter:

Vacuum Processing by Eurotherm on 21th Nov. 2013.

Non destructive testing by Vivid Technologies on 29th Nov.2013.

Further details will be intimated by E-mail.

Role of Energy Efficient and Reliable Equipment in the Global Scenario- M/s MTS Systems

M/s N. Aruna Director,MTS Systems delivers a technical talk.

A technical talk on "Role of Energy Efficient and Reliable Equipment in the Global Scenario was delivered on the Annual Day - 10th August 2013 by Ms.N.Aruna, Director-MTS Systems.

The talk was very much appreciated by the audience.

A Technical Program on Design of Experiment

Mr P. Deshpande explaining an aspect of Design of Experiment

The program on Design of Experiment by Mr.Pravin Deshpande, General Manager RSB Transmission India Ltd., was held at College of Engineering, Pune on 10.10.2013. Design of Experiments may be classified as part of six sigma. Mr.Deshpande went on to explain the aspect of Design of Experiments by giving very simple examples to explain the concept..The program was well received by the audience.

FUNCTIONALLY GRADED MATERIALS

Priyanka Deo And Kirti Petkar

Cummins College Of Engineering For Women, Karvenagar, Pune - 411052

Abstract:

The term "Functionally Graded Material" generally refers to a material in which the composition changes in a continuous manner from one target value to another. These are graded materials for applications in which there is a need for different material characteristics in the same component. The aim of this paper is to study the history of FGMs, the different types of FGMs and the latest techniques of manufacturing these FGMs and their uses. The paper looks at the advantages and disadvantages of FGMs. Various applications of these materials are touched upon. FGMs offer great promise in applications where the operating conditions are severe. For example, wear-resistant linings for handling large heavy abrasive ore particles, rocket heat shields, heat exchanger tubes, thermoelectric generators, heat-engine components, plasma facings for fusion reactors, and electrically insulating metal/ceramic joints. They are also ideal for minimizing thermo mechanical mismatch in metal-ceramic bonding. FGMs are of practical interest because a wide gradation of physical and/or chemical properties can be achieved across a given material depending on the material designs.

Keywords: FGM, FGM Applications, FGM processing Techniques.

INTRODUCTION

FGM is a two component composite characterized by a gradual change in material properties over volume. It is an anisotropic composite material where a material gradient has been deliberately introduced over two different materials. The gradient can for example be in composition and/or in microstructure. By applying this concept, materials like ceramics and metals can be brought together with a gradual change from one material to another. Functionally Graded Material (FGM) belongs to a class of advanced material characterized by variation in properties as the dimension varies. A material can be considered to be an FGM even if the gradation of the material ingredients is limited to a specific location in the material such as the interface, a joint, or a surface. In contrast, traditional composites are homogeneous mixtures, and they therefore involve a compromise between the desirable properties of the component materials.

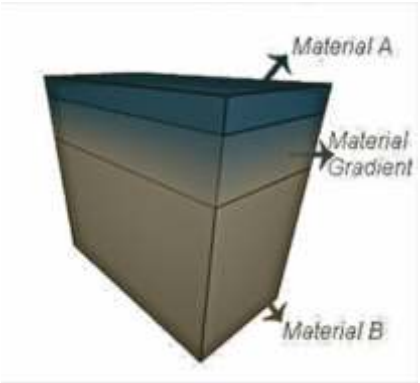

Fig .1 Concept of FGM

HISTORY OF FGM

1984 Sendai Group proposed a concept of FGM (Nino, Koizumi and Hirai). 1985 Establishing the concept of FGM. 1986 Investigation and research conducted for FGM (with Special Coordination Funds for Promoting Science and Technology). 1987 Launching a National Project called FGM Part I (with Special Coordination Funds for Promoting Science and Technology) (to be ended in March, 1991) Title:" Research on the Generic Technology of FGM Development for Thermal Stress Relaxation" The 1st FGM symposium. 1990 The 1st International Symposium on Functionally Graded Materials (FGM 1990) in Sendai, Japan.

TYPES OF FGM

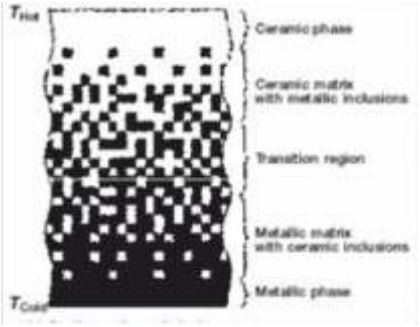

Fig .2 Continuous Graded Type

PROCESSING TECHNIQUES

There is wide variety of processing methods to fabricate FGMs available today. The processing methods can be classified into those based on constructive processing and those based on mass transport.

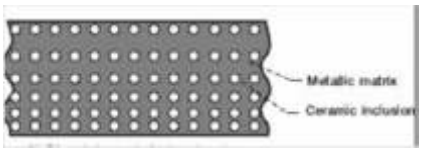

Fig .3 Discrete Graded Type

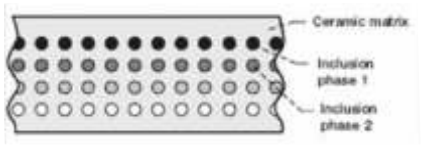

Fig .4 Multiphase Graded Type

A) VAPOUR DEPOSITION TECHNIQUE

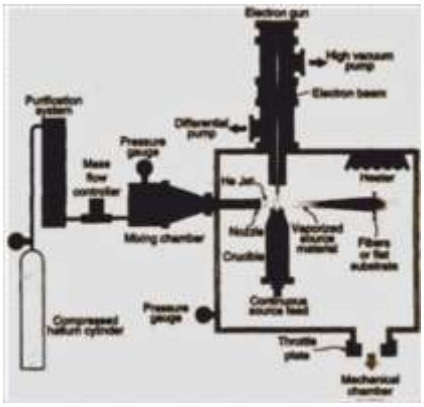

Fig .5 Apparatus of the DVD Technique

These vapor deposition methods are used to deposit thin functionally graded surface coatings and they give excellent microstructure. They are energy intensive and produce poisonous gases as their by products. The directed vapor deposition (DVD) technique uses a combination of electron-beam (or resistive) evaporation coupled with a supersonic carrier gas jet to deposit a potentially wide variety of materials. It uses a continuously operating 60 kV/10 kW e-beam gun to evaporate rapidly a variety of materials from a continuously fed skull melt contained in a water cooled crucible. The small beam diameter (0.4 mm) and the high accelerating voltage (60kV) of the DVD system's axial e-beam make possible high rate evaporation in a relatively unexplored low vacuum (10-3-10 Torr) e-beam processing environment. To function in this low vacuum environment, the axial e-beam gun employs differential pumping of the gun column. The electron-beam impinges upon a small diameter source rod contained within a water- cooled copper crucible. The impinging electrons heat the rod stock and form a molten evaporant pool along its top surface. The edges of the rod stock, in contact with the cooled crucible wall, remain solid. Thus, a 'skull' encased melt is formed which ensures that the molten portion of the rod stock comes only into contact with solid portions of the rod stock. By containing the melt inside of a solid skull of its own composition, undesirable melt/crucible reactions leading to contamination of the vapor stream are prevented. This high accelerating gas jet and heated metal when combined in low vacuum form a thin coating, which gets deposited on the substrate thus functionally grading it.

B) POWDER METALLURGY TECHNIQUE

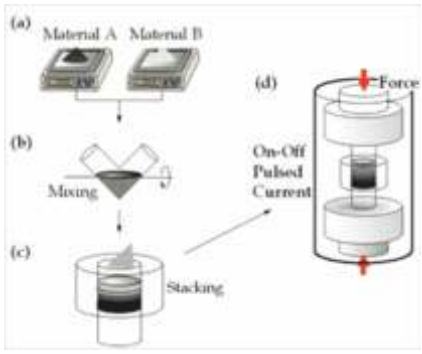

Fig .6 Schematic Representations of the Steps involved in Powder Metallurgy Technique

This method consists of three main steps. At first, materials desired in powder form are weighed and mixed. Next step is stepwise stacking of premixed powder according to a predesigned spatial distribution of the composition. Last step is Spark Plasma

Sintering. The FGM fabricated by this method, usually have the stepwise structure, and it is difficult to produce the FGM with continuous gradient.

C) CENTRIFUGALTECHNIQUE

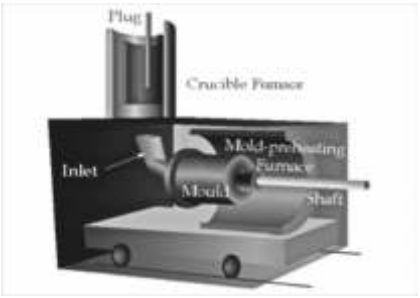

Fig .7 Apparatus Used in the Centrifugal Technique

It is possible to produce the FGMs with continuous gradients. In this case, a centrifugal force applied to a homogeneous molten metal, dispersed with ceramics particles or intermetallic compound particles, which drives the formation of the desired gradation. The composition gradient is then achieved primarily by the difference in the centrifugal force produced by the difference in density between the molten metal and solid particles. The force of gravity is used through spinning of the mould to form bulk functionally graded material .The graded material is produced in this way because of the difference in material densities and the spinning of the mould.

D) CENTRIFUGAL SLURRY METHOD

In this method, slurry with two types of solid particles, high-velocity particle and low velocity particle, is subjected to the centrifugal force during the fabrication of FGMs .The gradation of the material occurs base on the rates of migration of the two particles. After complete sedimentation occurs, liquid part of the slurry will be removed, and therefore, it does not become a part of FGM.

MICROSTRUCTURES OF FGM PRODUCED BY CENTRIFUGAL TECHNIQUE

The figures below show the typical microstructure of the Al/SiC FGM fabricated by the centrifugal method. Black and White are SiC and Al matrix, respectively.

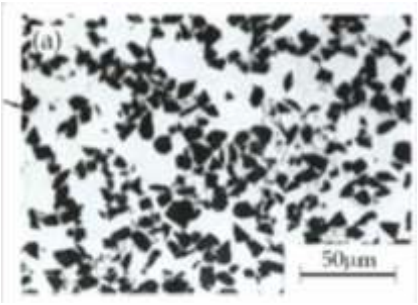

Fig. 8 Microstructure at 4.1 mm from outer periphery of the ring

Fig. 9 Microstructure at 0.5 mm from the outer periphery of the ring

APPLICATIONS OF FGM

1) MEDICAL

The human bone is an example of a FGM. A gradual increase in the pore distribution from the interior to the surface can pass on properties such as shock resistance, thermal insulation, catalytic efficiency, and the relaxation of the thermal stress. The distribution of the porosity affect the tensile strength and the Young's modulus .The human bone have high strength at the surface as it gradually lowers towards the inside by altering the porosity. The human bone is a remarkable material having unique material properties that has the ability to repair itself and to adapt to its mechanical environment. Bones exhibit a piezoelectric effect used both for detecting an external stress and to remodel bone structures so that no peak stress is developed at any point. Many bones undergo combined loading (axial, torsion, and bending loading). Under certain loadings, bones break and joints wear out. Our advantage is that our skeletal system is usually able to repair itself.

Fig .10 Detailed Sketch of the Human Bone

CARPAL SKIN

Fig .11 A sample of Carpal Skin on Hand

Carpal skinis a process by which to map the pain-profile of a particular patient - its intensity and duration - and distribute hard and soft materials to fit the patient's anatomical and physiological requirements limiting movement in a customized fashion. The formation process involves case-by-case pain registration and material property assignment. The 3-D scan of the patient's hand, including its pain registration, is mapped to a 2-D representation on which the distribution of elastic modulus is applied. This pain-map is then folded back to its 3-D form and 3-D printed using photopolymer composites.

2) AEROSPACE

Functionally graded materials can withstand very high thermal gradient, this makes it suitable for use in structures and space plane body, rocket engine component etc. Aerospace equipment and structures like (TiAl-SiC fibers) Rocket nozzle,

Heat exchange panels, Spacecraft truss structure, Reflectors, Camera housing, Turbine wheels (operating above 40,000 rpm), Nose caps and leading edge of missiles and Space shuttle.

Fig .12 Rocket Thrust Chamber

3) DEFENCE AND ENERGY

It is used as a penetration resistant materials used for amour plates and bulletproof vests. FGM are used in energy conversion devices. They also provide thermal barrier and are used as protective coating on turbine blades in gas turbine engine.

4) OPTOELECTRONICS

FGM finds its application in optoelectronics as graded refractive index materials and in audio-video discs magnetic storage media. Now days the graded materials are widely used for anti- reflective layers, fibers and other passive elements made from dielectrics, and also for sensors and energy applications. The modulation of refractive index can be obtained in such components through the change in material composition of optoelectronic devices.

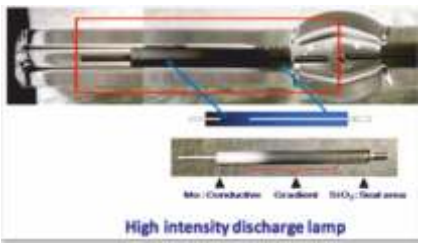

Fig .13 High Intensity Discharge Lamp

RECENT RESEARCH EFFORTS IN FGM

In recent years the concept of FGM has become more popular in Europe more particularly in Germany. A trans-regional collaborative research center (SFB Trans-regio) is funded since 2006 in order to exploit the potential of grading mono-materials, such as steel, aluminum and poly-propylene, by using thermo-mechanically coupled manufacturing processes. In India, companies like Zimmer India, Diamorph Inc Exactech Ltd. use FGM concept to manufacture components like hip joints, carpal skin, etc.

CONCLUSION

FGM belongs to novel material category and offers new capabilities to use it at large scale. FGM technology has the potential to drastically redefine the methods used for developing lighter, stronger, and high performance structures with unique and nontraditional properties. FGM-composites often lead to a reduction in weight and costs, and are more environmental friendly. For these reasons the popularity of these composites is increasing in the engineering world. Functionally graded materials are perspective materials for modern optoelectronic devices, such as low threshold current edge lasers and tunable photo detectors. Graded layers can also be used as buffers in heteroepitaxy of nitrides.

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3. Daniel Lin, Qing Li, Wei Li, Michael Swain," Bone Remodeling Induced by Dental Implants of Functionally Graded Materials", Wiley Inter Science, DOI: 10.1002 / jbm.b.31531.

PRIYANKA DEO

Currently pursuing her Bachelor's Degree in Mechanical Engineering (Second Year) from Cummins College of Engineering. Priyanka Deo a resident of Chinchwad has completed her schooling from St. Andrews High School in Chinchwad and stood topper by scoring an impressive 94.5% marks in her SSC exams. She passed out her HSC exams from Fergusson College with 88% aggregate marks.

She is very fond of listening to Music, travelling and a student of "Kathak" for last more than 9 years. She plans to pursue her higher studies in Aeronautical Engineering after completion of graduation.

KIRTI PETKAR

Currently studying in Second Year Mechanical Engineering from Cummins College of Engineering. She is a past student of St. Joseph's High School, Pashan.

She scored 92.18% in her SSC examination and an aggregate of 89% in HSC examination. She scored distinction in the first year of Engineering. She is interested in basketball and has represented her school and Deccan Gymkhana.

She is interested in pursuing a career in Automobile Design.

Know Our Members

Mr. Sushil Verma

This year we have new member in ASM Pune Chapter – Aichelin Unitherm Heat Treatment Systems India Pvt. Ltd., Talegaon. The company is a 50:50 JV between Aichelin Holding GmbH, Austria and Unitherm Engineers Ltd, India started in March 2010.

Mr. Sushil Verma is the Chief Executive Officer who is looking after the JV company in modern manufacturing facility at Talegaon Industrial Area, Pune. Mr. Verma is Graduate in Mechanical Engineering and Post Graduate in Business Administration with 25 years of extensive experience in Sales, Business Development, Production and as Profit Centre Head. He is from Capital Equipment Industry and his earlier assignments were with TAL Manufacturing Solutions Ltd as Business Unit Head (Machine Tools Division), Electronica Machine Tools Ltd as General Manager & Plant Head, Godrej & Boyce Mfg. Co. Ltd as Regional Manager (Machine Tools & Process Equip. Divisions) and with ISGEC&Punj Lloyds.

He has extensively travelled to more than 18 countries like Spain, Germany, Italy, Japan, Austria, Switzerland, Finland, Sweden, South Korea, China, UAE etc and attended no. of International Exhibitions like Euro Blech – Germany & Italy, EMO – Hannover, CIMT – China, TIMTOS - Taiwan, SIMTOS - South Korea, IMTEX & AMTEX in India etc.

He has also attended no. of specialized courses for Senior Management like Leadership Development from Vienna University, Tata Business Excellence Model, Mercury Goldman, Dale Carnegie etc.

The JV company designs and manufactures the following Heat Treatment Furnace lines in India as per International Quality:

1) Sealed Quench Chamber Furnace Lines.
2) Bainitising Furnaces.
3) Pusher Type Continuous Furnace Lines.
4) Rotary Hearth Furnaces.
5) Ring Hearth Furnaces.
6) Roller Hearth Furnaces.
7) Horizontal Sealed Retort & Retort less NitridingFurnaces.
8) Vertical Pit Type Sealed Retort & Retortless Furnaces.
9) Endo Gas Generators.
10) Mesh Belt Furnaces.
11) Cast Link Conveyor Belt Furnaces.
12) Pre Heating and Stress Relieving Furnaces.
13) Process Control and Automation Solutions.
14) Aluminium Tower Type Melting Holding Furnaces.
15) Aluminium Batch Tilting Type Furnaces.
16) Aluminium Sand Baking Furnaces.
17) Aluminium Solutionising and Aging Furnaces.
18) Aluminium Vertical Bottom Drop Solutionising Furnaces.

All major Car, Trucks, Buses, 2 Wheelers, Tractors, Bearing, Fasteners, Gears, Blades, Textile & Auto Component manufacturers are customers in India and abroad.

Handing of Memento to Mr. Sushil Verma, CEO - Aichelin Unitherm by Mr. L D Deshpande Chairman Membership Development ASM Pune

Program on Metallurgy for Non Metallurgists

A Three day Program on Metallurgy for Non Metallurgists was held at ARAI, Paud Road, Pune from 12th to 14th September 2013. The program was conducted jointly by ARAI and ASM Pune. The Faculty for the program comprised of Senior Materials Engineering Professionals from the Industry & Senior Educationists. There were 41 participants from all over India. Congratulations to Mr.K.C.Gogate and his team for the success of this program.

OBJECTIVE OF THE PROGRAMME

In today's times of Globalization, it is essential to widen the Knowledge Base of Individuals. Metallurgy for the Non-Metallurgist provides concise yet thorough overview of metallurgy as it is applied in the industry today. Metals and alloys are used in the greatest variety of applications of all engineering materials. As such, it is essential for those involved in manufacturing, engineering and construction to have an understanding of what metals are, how they behave, and why they behave differently than ceramics, glass, and plastics. It is also important to understand how they can be made stronger or more corrosion resistant, how they can be shaped by casting, forging, forming, machining, or welding, and how these processes can alter properties. This ASM course provides this important knowledge to those who are not metallurgists, and it covers up Metallurgy from the history of metals to its fabrication into usable products.

Such programs will be regularly conducted by ASM.

We have moved back to our old office at

ASM INTERNATIONAL 100th ANNIVERSARY 1913-2013

ASM International Pune Chapter

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