ASM Cleveland Chapter Symposium on Materials for Extreme Environments

Presentations and Speakers

1) Beryllium and Its Applications:

Beryllium is one of those elements most people do not know about, yet it plays a critical role in our life. Thanks to beryllium, medical isotopes are created in nuclear reactors around the world where they serve as neutron moderators and reflectors. Beryllium has also played a critical role in space exploration being used in satellites, launch vehicles and instrumentation, because of its incredibly high stiffness to weight ratio. X-ray generators used in the medical industry also rely on its "transparent" properties to x-rays. A review of beryllium's properties and uses will be described.

Coming off the bench for Edgar Vidal is Don Hashiguchi. Don is a product of local education with a BS in Biomedical Engineering and MS in Metallurgy and Materials Science both from Case Western Reserve University. He also received an MBA from John Carroll University. He has worked for Materion for 31 years in Cleveland, Lorain and Elmore. He has worked primarily in R&D functions for Beryllium Products and for several years in the Alloy group. He was previously Process Engineering Manager before being appointed as Principal Engineer. He co-authored a section in "Beryllium Chemistry and Processing," co-authored a chapter in the recent release of ASM Handbook Volume 7, "Beryllium and Aluminum Beryllium Alloys," and even though he doesn't know much about telescopes co-authored an article in a fall AM&P article "Beryllium Mirrors for Space Telescopes." He was in the 2014 class of ASM Fellows.

2) Advanced Magnetic Materials for High Power Density, High Efficiency Electrical Systems:

Electrical power generation, distribution, and conversion systems are key components of infrastructure technology in several industrial sectors. There is continual demand for electrical systems with higher power density that must also meet aggressive efficiency and reliability requirements. Future applications such as hybrid electric aircraft propulsion systems will demand the highest performance and reliability in extreme temperature, high voltage, and high frequency environments. Advanced magnetic materials are critical to the performance of these systems. The complementary needs of high power density and high system efficiency demand components that exhibit low power loss at high frequencies. The trend in power conversion technology is to move away from low frequency transformers to modular power electronic systems with high frequency transformers. New magnetic materials are under development that are operable from the MW-level-20 kHz range up to the kW-level -MHz range with operating temperatures up to 300 °C. Advanced electric machines and drives, often with permanent magnet architectures, are being developed to operate at continually higher speeds and temperatures. Novel machine architectures are enabled by newly developed alternatives to traditional electrical steels and rare earth permanent magnets. Novel magnetic materials, including dual phase soft magnetic laminates and nanocomposite permanent magnets, will be described. Strategies for improved magnetic material performance will be discussed that include nanoscale structure control, novel device geometries, new alloy and compound development, and improved processing methods to maintain a sustainable value chain.

Dr. Frank Johnson joined GE Global Research in 2005 as a Materials Scientist in Ceramic and Metallurgy Technologies. His current research focuses on the development of magnetic materials for power generation, distribution, and conversion technologies. Frank's area of expertise is the structure-processing-property relationships of crystalline, nanocrystalline, and amorphous soft magnetic alloys, rare-earth permanent magnets, and magnetocaloric materials.

Prior to joining GE, Frank received was a Post-Doctoral Fellow in the Magnetic Materials Group, Metallurgy Division of the National Institute of Standards and Technology in Gaithersburg, Maryland. While at NIST he worked on magnetocaloric materials, magnetic thin-films, and assisted in the development of magnetic Standard Reference Materials.

He received his Ph.D. in Materials Science and Engineering from Carnegie Mellon University in 2003, and his thesis topic was in the area of Fe-Co based nanocrystalline soft magnetic alloys (HITPERM). He received an M.S. in Materials Science and Engineering from the Massachusetts Institute of Technology in 1999 and a B.S. in Materials Science and Engineering from Carnegie Mellon University in 1996.

3) Refractory Metals: The Merits of Stubborn Resistance:

While several different definitions of the term "refractory metal" exist, they all include Nb, Mo, Ta, W, and Re because the melting temperatures of all these elements are well above 2,000 °C. This unique characteristic has led to their successful use in elevated-temperature environments, but in a broader sense they are "refractory" to environments other than high temperature. In fact, applications at room temperature and below account for the majority of refractory-metal applications and consumption, and many of these applications pose significant environmental challenges to materials. This presentation will provide an overview of several challenges that refractory metals meet and master.

Dr. John Shields holds B.S., M.S., and Ph.D. degrees in Metallurgy and Materials Science from Case Western Reserve University. He is president of Mill Creek Materials Consulting and a principal in PentaMet Associates. His clients in the refractory metals business include producers, fabricators, end users, and investors. Prior to consulting, he spent 25 years with Climax Molybdenum Research Laboratory, Climax Specialty Metals, CSM Industries, and H. C. Starck, Inc.

John is the author or co-author of over forty publications and two patents. He is a member of ASM International, APMI, ASTM, and TMS, having held local and national offices in these organizations. He has served on the editorial board of *Advanced Materials and Processes*, is currently a member of the editorial board of the *International Journal of Refractory Metals and Hard Materials*, and has reviewed technical papers in the refractory metals area for *Metallurgical and Materials Transactions A*.

John is a Fellow of ASM International and a recipient of the ASM International Cleveland Chapter Award of Distinction. He is a recipient of Cleveland Engineering Week Committee's Engineer of the Year award and Cleveland Technical Societies Council's Robert B. Cummings Distinguished Leadership Award.

4) C/C Composite Materials for Aerospace Friction & Wear Applications:

Goodrich Aircraft Wheels & Brakes (now UTC Aerospace Systems – Landing Systems) first offered carbon fiber reinforced/carbon matrix (or C/C) composite brakes as a replacement to metallic friction materials on a series of commercial programs back in the late 1970s. Carbon brakes exhibit improved mechanical strength under normal braking conditions, more consistent friction and wear performance, and are lighter than the incumbent steel brakes. With this decision, UTAS established an infrastructure to develop optimized material designs, low-cost processing approaches, sub-scale performance testing, and environmental degradation protection schemes and facilities to support production including acquiring Super Temp (Sante Fe Springs, CA) and building two additional production facilities in Pueblo, CO, and Spokane, WA. The limiting factors for the life of any C/C friction material is wear and oxidation damage from a wide range of operating conditions. An overview of the mechanisms of oxidation degradation and wear and the methods for protecting and extending the life of C/C friction materials will be presented.

Dr. Robert Bianco has a B.S., M.S., and Ph.D. in Metallurgical Engineering from The Ohio State University and an Engineering/Technology Management Certificate from Caltech's Industrial Relations Center. He joined Goodrich's (now United Technologies Aerospace Systems) Materials and Simulation Technical Center in 1997 where he has held positions of increasing responsibility and is currently the Manager, Materials and Process R&D. He is responsible for advancing the state-of-the-art in materials and their processes for the aerospace industry and for managing an average annual R&D budget of $5M. Prior to joining Goodrich, he was a Senior Engineer at Westinghouse's Bettis Atomic Power Laboratory responsible for the development of material systems for advanced energy conversion applications. His current involvements include the development and implementation of protective coatings for the prevention of oxidation on carbon fiber reinforced/carbon matrix composite materials, the development and validation of light-weight engineered nanomaterials, and the assessment and development of advanced manufacturing processes for aerospace applications including additive manufacturing. Dr. Bianco's technical background and expertise includes high-temperature structural materials (e.g., dispersion strengthened metallics), process metallurgy (e.g., ingot: sand and investment casting; powder: metal injection molding, hot isostatic pressing, vacuum sintering, etc.; thermomechanical: extrusion, forging, swaging, rolling, wire drawing), materials characterization (SEM, LOM), mechanical testing (tensile, fatigue, impact, hardness), failure analyses/investigations, and surface modifications (diffusion coatings, CVD, plating, chemical conversion). United Technologies is a leading global supplier of systems and services to the aerospace and defense industry. United Technologies offers an extensive range of products, systems and services for aircraft and engine manufacturers, airlines and defense forces around the world. Our products can be found on almost all the aircraft in the world.

5) Multiscale Ceramic Integration Technologies for Energy and Environmental Applications:

Multiscale ceramic integration technologies dramatically impact the energy and environment landscape due to wide scale application of ceramics in all aspects of alternative energy production, storage, distribution, conservation, and efficiency. Examples include fuel cells, thermoelectrics, photovoltaics, gas turbine propulsion systems, distribution and transmission systems based on superconductors, nuclear power generation, NOx and COx reduction technologies, and a wide variety of green manufacturing processes and technologies. Various multiscale ceramic integration technologies play a role in fabrication and manufacturing of large and complex shaped parts of various functionalities. However, the development of robust and reliable integrated systems with optimum performance requires the understanding of many thermochemical and thermomechanical factors, particularly for high temperature applications. In this presentation, various challenges and opportunities in design, fabrication, and testing of integrated similar (ceramic-ceramic) and dissimilar (ceramic-metal) material systems will be discussed. Potential opportunities and need for the development of innovative design philosophies, approaches, and integrated system testing under simulated application conditions will also be discussed.

Dr. Mrityunjay (Jay) Singh is Chief Scientist at the Ohio Aerospace Institute, Cleveland, Ohio. He is also the President of the American Ceramic Society, Governor of Acta Materialia, Inc., and Academician of the World Academy of Ceramics, Italy, where he currently serves as Vice President of the International Advisory Board of the academy. The recipient of more than 65 national and international awards and prizes worldwide, Dr. Singh is editor or co-editor of 50 books/proceedings; 7 special journal volumes; author or co-author of 14 book chapters; and more than 275 papers in various journals and proceedings. He has delivered numerous keynote and plenary presentations in international conferences, forums, and workshops, and serves on the advisory boards and committees of more than fifteen prestigious international journals and technical publications.

6) Diamond – Its Promise and Realization in Engineering and Medicine:

Diamond is a unique material for engineering applications due to its combination of exceptional chemical, mechanical, electronic and optical properties. Yet, commercial realization of diamond-based products has been continually hindered by issues of integration with other materials, or the fabrication of the appropriate diamond films or bulk crystals. Diamond is now being considered in a vast array of medical applications and could lead to improvements in medical diagnosis and treatment. Progress and challenges of the use of diamond in these areas will be presented, including insights from our primary focus area of implantable neural electrode devices.

Dr. Heidi B. Martin is currently an Associate Professor in the Chemical & Biomolecular Engineering Department at her alma mater, Case Western Reserve University. In her studies at Case, she received her B.S. degrees, in chemical engineering and chemistry, and the M.S. and Ph.D. degrees in chemical engineering. Prior to joining the faculty at Case, she was an NIH Postdoctoral Fellow and worked in analytical chemistry at the University of North Carolina, Chapel Hill. Her current research focuses on engineering of diamond materials for electrochemical devices, with emphasis on implantable biomedical devices, including neurosensors and neural stimulators.