Manufacturing Science and Technology
Room: 202 B - Session MS+AS+EM+EN+NS+TF-MoM

IPF 2013-Manufacturing Challenges: R&D Perspective (8:20-9:40 am) / Energy Storage (9:40 am-12:00 pm)
Moderator: K. Amm, GE Global Research, B.R. Rogers, Vanderbilt University

8:20am **MS+AS+EM+EN+NS+TF-MoM1 From Quanta to the Continuum: Opportunities for Mesoscale Science**, ***G. Crabtree***, Argonne National Laboratory **INVITED**

Mesoscale science embraces the regime where atomic granularity and quantization of energy yield to continuous matter and energy, where high levels of complexity and functionality emerge from simple components, and where disparate degrees of freedom interact to produce entirely new behavior. Mesoscale science builds on the ever-growing foundation of nanoscale tools and insights that the community has developed over the last decade and continues to develop. Control of mesoscale complexity offers new scientific and technological opportunities: applying our mastery of nanoscale interactions to discover and design new architectures from the "bottom up" that display innovative macroscopic behavior and functionality. This constructionist approach to designing and building new functional architectures creates new horizons for mesoscale manufacturing, where principles of design and implementation differ fundamentally from conventional "top down" macroscopic approaches. Examples of mesoscale successes, challenges and opportunities will be described.

A more complete discussion of mesoscale science can be found in the BESAC report, *From Quanta to the Continuum: Opportunities for Mesoscale Science*, http://science.energy.gov/bes/news-and-resources/reports/basic-research-needs/

Innovative community input on opportunities for mesoscale science can be found on the *Mesoscopic Materials and Chemistry* website, http://www.meso2012.com/

9:00am **MS+AS+EM+EN+NS+TF-MoM3 The National Network for Manufacturing Innovation – Towards a New Innovation Ecosystem for Advanced Manufacturing**, ***M. Molnar***, National Institute of Standards and Technology **INVITED**

A key challenge to restoring U.S. leadership in advanced manufacturing is addressing the so-called "missing middle" – the technical and business barriers of scaling-up an innovative new material, process, or technology for robust production use. This plenary talk explores the National Network for Manufacturing Innovation as a means to accelerate U.S. innovation. As proposed by President Obama NNMI is a network of manufacturing institutes where Industry and Academia partner on industry-relevant challenges. Each institute would be chartered in a competitively selected topic and focus on nationally important, precompetitive technologies to create "innovation hubs" for transformational impact.

This plenary will review the NNMI progress to date, including the current design of the institute and supporting network and core functions. The emerging design builds on the extensive public input and the progress of the pilot institute on Additive Manufacturing, explored in detail in the following plenary. The discussion concludes with a review of the three manufacturing institutes topics being established this year.

9:40am **MS+AS+EM+EN+NS+TF-MoM5 Conformal Thin Films- The Use of Atomic Layer Deposition in Energy Related Applications**, ***G.M. Sundaram***, Ultratech/Cambridge NanoTech **INVITED**

Atomic Layer Deposition (ALD) is a unique thin film deposition technique based on sequential precursor usage with self-limiting reactions, which yields films with excellent uniformity, density, conformality, and interface quality . This is turn has set the stage for its use in a wide array of technology areas. In this work, the principles of ALD will be covered, along with an examination of the intersection points between ALD and a number energy related structures - including storage devices.

10:40am **MS+AS+EM+EN+NS+TF-MoM8 Manufacturing a Three-dimensional, Solid-state Rechargeable Battery**, ***A. Prieto***, Colorado State University, *D. Johnson*, Prieto Battery, Inc. **INVITED**

There are two main limitations to the rate of charging for Li-ion batteries: slow diffusion of Li^+ into the electrodes and slow diffusion *between* them. The synthesis of high surface area electrodes has been shown to dramatically enhance performance because reducing the particle size of the electrode material reduces the distance the Li^+ ions have to diffuse. *The problem of decreasing the Li^+ diffusion length between electrodes has not yet been solved.* We are working to incorporate high surface area foams of a novel anode material into a new battery architecture wherein the foam is conformally coated with an electrolyte made by electrochemical deposition, then surrounded by the cathode electrode. The significant advantage to this geometry is that the diffusion length for Li^+ between the cathode and anode will be dramatically reduced, which should lead to much faster charging rates. However, if this battery is going to be useful and commercializable, it must be manufactured using low cost, reliable, scalable methods. I will present preliminary results on the initial stages of the battery architecture, including the fabrication of anode foams conformally coated with a polymer electrolyte. The reversibility of the intercalation into the anode and the ionic conductivity of the polymer electrolyte will be discussed.

11:20am **MS+AS+EM+EN+NS+TF-MoM10 Defects, Nonuniformities, and Degradation Mechanisms in Batteries**, ***S. Harris***, Lawrence Berkeley National Laboratory **INVITED**

We review work from our laboratory that suggests to us that most Li-ion battery failure can be ascribed to the presence of nano- and microscale inhomogeneities that interact at the mesoscale, as is the case with almost every material; and that these inhomogeneities act by hindering Li transport. (Li does not get to the right place at the right time.) For this purpose, we define inhomogeneities as regions with sharply varying properties—which includes interfaces—whether present by "accident" or design. We have used digital image correlation, X-Ray tomography, FIB-SEM serial sectioning, and isotope tracer techniques with TOF-SIMS to observe and quantify these inhomogeneities. We propose new research approaches to make more durable, high energy density lithium ion batteries.

Authors Index

Bold page numbers indicate the presenter