

Member Views of Materials News 2010

Lynne Robinson

Intertwined with many of the top headlines of 2010 was a materials story. To highlight the critical role that materials science and engineering (MSE) plays on both the world stage and in everyday lives, *JOM* asked an array of members to comment on what they believe the most significant news or development was in 2010 from a materials

perspective. We also encouraged them to offer predictions as to what might lie ahead for MSE in 2011 and beyond. Many of the individuals who responded are involved with TMS technical or general committees and their responses reflect those particular interests.

What follows are excerpts from the many exceptional contributions to this

article, arranged according to the four broad technical communities that TMS has developed for its Materials Technology@TMS resources. The full text of these responses, as well as links to the papers, websites, and resources referenced in many of them, can be accessed at the Materials Technology@TMS link provided in each section.

Please note that the opinions expressed in this article are solely those of the authors and not of their places of employment or TMS.

Emerging Materials Technologies Community

Materials Technology@TMS link: <http://materialstechnology.tms.org/EMT/article.aspx?articleID=3793>

Nitin Chopra

*Assistant Professor, Metallurgical and Materials Engineering, Center for Materials for Information Technology The University of Alabama, USA
Member, Biomaterials Committee*



The future of nanomedicine necessitates fundamental knowledge and development of novel drug delivery systems, their clever implantation in humans, and finally, precisely controlling delivery of the drug molecules to cure a disease. A recent publication in *Proceedings of the National Academy of Sciences* (Kolishetti et al., *Proceedings of the National Academy of Sciences*, 107 (2010) 17939–17944) reports the use of biodegradable polymeric nanoparticles as efficient delivery vehicles for multiple cancer drugs. This was achieved by precise blending of drug molecules with polymers, resulting in a polymer-based nanoparticle loaded with two different drugs with different properties. The drug is released precisely once

the interaction with the tumor cells is established. Such particles will also eliminate difficulties and risks associated with chemotherapy.

Diana Farkas

*Professor, Materials Science and Engineering Virginia Polytechnic Institute and State University, USA
Member, Computational Materials Science and Engineering Committee*



A computational materials science approach has been used for many years to study deformation and failure in metallic materials from the atomistic scale up, starting with the basic interaction between atoms. A new, exciting development is the application of these techniques to biological systems, as evidenced by the work of Markus Buehler, associate professor at the Massachusetts Institute of Technology, who has studied deformation and failure of structural protein materials, such as spider silk.

... This will enable the design of new generations of multifunctional materials with improved properties by using the principles that are observed in the natural biological geometries.

Fu Guo

*Associate Dean, College of Materials Science and Engineering Beijing University of Technology, China
Member, Electronic Packaging and Interconnection Materials Committee*



Novel UBM layers and/or solder alloys will continue to emerge in 2011 and beyond. Such innovative scientific/engineering activities can be achieved through the microstructure design of interfacial intermetallic compounds. Accordingly, portable electronic devices with high-density packaging technologies/materials can enrich the user experience for modern society. In other words, the “More than Moore” can keep running for the next decade.

C. Robert Kao

Professor and Chair, Department of Materials Science and Engineering National Taiwan University, Taiwan Chair, Electronic Packaging and Interconnection Materials Committee

The growing interest in three-dimensional integrated circuits (3D ICs) represents a paradigm shift related to electronic packaging and interconnection materials. It also presents new challenges and opportunities for researchers. . . . A key pillar for the successful implementation of 3D IC integration is to have reliable metallurgy bonding between different layers of silicon chips. In 2011 and beyond, we will see exponential growth in research activities in this area, including new low temperature bonding materials, new surface finishes, new bonding processes, and identification of new failure modes.



Fernand D.S. Marquis

Professor, Wayne E. Meyer Institute of Systems Engineering Naval Postgraduate School, USA JOM Advisor, Powder Materials Committee

Expect to see the use of a system approach to the design, development, and manufacture of complex and sophisticated functional nanosystems. As a consequence, there will be considerable breakthroughs in several fields such as energy, health, catalysis, sensors, and water purification.



Georg J. Schmitz

Access e.V. RWTH Aachen University, Germany Member, ICME Committee

Efforts to standardize and generalize data formats



Nitin Singh

Researcher Novelis Global Technology Centre, Canada Member, ICME Committee

The aluminum industry has, over the years, been a big promoter of using an ICME (integrated computational materials engineering) approach for alloy development. However, it is only recently with the development of sophisticated multi-scale modeling capabilities that a quantitative understanding of physical mechanisms involved and their interactions are being generated. I consider the joint paper, "Quantitative Prediction of Solute Strengthening in Aluminium Alloys," published in *Nature Materials* (DOI:10.1038/NMAT2813) by researchers at Brown University and the GM Technical Center as a significant development in building up capabilities towards an ICME approach to alloy development. The authors used a new computational approach to quantify solute-dislocation interaction at the nanoscale and related it to the macro-scale contribution of solute strengthening in aluminum alloys.



I believe this work very clearly shows the capability to make quantitative predictions using ICME tools correlating microstructure with property with a minimum number of free parameters. This should spur similar activity in understanding other mechanisms at play for which we probably have a good feel, but no quantitative understanding. Further, developing relationships with processing variables is key, from an industrial point of view, to engineering new materials and has the potential to revolutionize the metal/materials manufacturing sector in general.

for the exchange of simulation results represent a major step toward successful future applications of ICME (integrated computational materials engineering). Such a standard facilitates information exchange between software tools for numerous processes and also across the different length and time scales affecting both properties and life cycle of an engineering component. . . . This will substantially improve the understanding of individual processes by integrating the component history originating from preceding steps as an initial condition for the actual process. Eventually this will lead to optimized process and production scenarios and will allow effective tailoring of specific materials properties.

Patrice E.A. Turchi

Advanced Metallurgical Science and Engineering Group Leader, Condensed Matter and Materials Division Lawrence Livermore National



Laboratory, USA Member-At-Large, Materials and Society Committee Carbon, the fourth most abundant chemical element in the universe, enjoyed

a high moment of fame this past year when the Nobel Prize in Physics was awarded to two scientists from the University of Manchester for their ground-breaking experiments on two-dimensional graphene. Despite this instant recognition, a lot of work had been done in recent years on this "simple" structure—a one-atom thick film of carbon—to reveal its intriguing properties and promising applications. . . . It should also be pointed out that—as with fullerenes, carbon nanotubes, buckyballs, and other forms of carbon—state-of-the-art modeling tools currently available are perfectly adequate to unravel the mysteries of graphene. This situation should make both experimentalists and theorists work hand in hand for more discoveries. The exciting world of science may be flat after all. . . .

Yang Wen

Postdoctoral Researcher University of California,



San Diego, USA Member, Biomaterials Committee

The mechanism of the structure of natural materials can be introduced to nanotechnology