Wednesday Morning, November 2, 2011

Nanomanufacturing Science and Technology Focus Topic
Room: 111 - Session NM+AS+MS-WeM

Nanomanufacturing Issues: Metrology and Environmental Concerns
Moderator: J. Johnson, University of Tennessee Space Institute, W. Collins, Fisk University

9:00am **NM+AS+MS-WeM4 Particle Characterization Issues in Evaluating the Toxicity and Environmental Impact of Manufactured Nanomaterials**, ***K.W. Powers***, University of Florida

Nanostructured materials and nanoparticles promise to revolutionize many key areas of science and technology, however, the environmental effects of nanomaterial enabled products need to be considered throughout their lifecycle, from manufacture to environmental disposal. As nanomaterials become more commonplace in commercial applications, there is a need to assess the potential health and safety effects on human and other biological organisms. Materials at the nanoscale often possess properties that are different from the equivalent bulk or molecular scale. It is clearly shortsighted to assume that toxicological profiles of nanomaterials are the same as in the bulk or molecular forms. As they address these issues, toxicologists often need assistance in understanding and accommodating many of the unique attributes of nanoscale materials as they begin to assess potential health and environmental effects. Though the interpretation of the biological markers of toxicity are well developed, there are a number of issues relating to dosage, size, shape, detection and characterization that are problematic. There is a growing consensus that the complexity of these issues requires a multidisciplinary approach to nanoparticle toxicology that includes medical personnel, environmental and physical scientists as well as engineers trained in particle technology.

Keywords: nanoparticles, nanocharacterization, nanotoxicology, toxicity,

9:40am **NM+AS+MS-WeM6 Sampling for Airborne Nanoparticles and Selecting Respiratory Protection**, ***S.M. Hays***, Gobbell Hays Partners, Inc., *J.R. Millette*, MVA Scientific Consultants

As the manufacture and use of nanomaterials continue to increase, appropriate questions are raised about the release of airborne nanoparticles into the general environment and specifically into the breathing zone of people. The development of monitoring procedures specific to carbon nanotubes and other nanoparticles is crucial in determining the effectiveness of engineering controls and personal protection. This presentation will review experiments conducted to determine the efficacy of using asbestos air sampling methodology for sample collection with standard membrane filter cassettes and analysis using transmission electron microscopy (TEM). Tests done to evaluate the use of cartridge style respirator filters in carbon nanotube aerosols will also be presented. These laboratory tests will be discussed in relation to air samples collected in a variety of actual field use situations. Proposed methodology for the analysis for nanotubes in settled dust will be presented. Finally, one author is chairing an ASTM committee that is developing a consensus method to collect and analyze airborne nanotubes. The current state of that committee's work will be summarized.

10:40am **NM+AS+MS-WeM9 Local Probes Enabling Science and Manufacturing**, ***D.A. Bonnell***, University of Pennsylvania **INVITED**

The last decade has witnessed significant advances in measuring nanoscale phenomena. These advances have enabled scientific discovery and provided a framework to support some nanomanufacturing processes. Nevertheless, both scientific advance and to a greater extent manufacturing are limited by our current capabilities in nanoscale metrology. This talk will highlight some of the exciting advances in probe based metrology, project future developments and outline the challenges that are critical to realizing a robust nanomanufacturing sector. The outcome of a recent global assessment of Nano Metrology will also be summarized.

11:20am **NM+AS+MS-WeM11 The Influence of Surrounding Materials on the Optical Properties of Nanoscale Films: An Unforeseen Complication in Nanoscale Metrology**, ***A.C. Diebold***, *V.K. Kamineni*, University at Albany

Optical measurement of film thickness requires knowledge of the complex refractive index (dielectric function) of each material in the film stack. Practical experience has shown that the dielectric function changes with film thickness for many poly crystalline metal films and single crystal semiconductor layers. (1, 2) Previous studies pointed to quantum confinement induced changes in the dielectric function of thin silicon nanofilms between 10 nm and 2 nm. Extra Thin silicon on insulator (ET-SOI) films were used for this study. These films are often referred to as crystalline silicon quantum wells (c—SI QW). Our most recent study shows that the dielectric function of c-Si QWs can be further altered by the presence of a dielectric layer above the nano silicon top layer.(3) Based on an elastic theory description of the acoustic phonon modes, the dielectric function of the c-Si QWs is found to be strongly influenced by electron – phonon scattering. We illustrate this point using low temperature measurements of the dielectric function of a series of c-Si QWs and by comparing room temperature measurements of the dielectric function of 5 nm c-Si QWs with native oxide, 10 nm SiO_2, and 10 nm HfO_2.

1. Observation of quantum confinement and quantum size effects, A.C. Diebold and J. Price, Phys. Stat. Sol. (a) **205**, No. 4, (2008), pp 896–900.

2. Optical Metrology of Ni and NiSi thin films used in the self-aligned silicidation process, V. K. Kamineni, M. Raymond, E. J. Bersch, B. B. Doris, A. C. Diebold, J. Appl. Phys., **107,** (2010), pp 093525 1-8.

3. Evidence of phonon confinement effects on the direct gap transitions of nanoscale Si films, V.K. Kamineni and A.C. Diebold, submitted

Authors Index

Bold page numbers indicate the presenter

— B —

Bonnell, D.A.: NM+AS+MS-WeM9, **1**

— D —

Diebold, A.C.: NM+AS+MS-WeM11, **1**

— H —

Hays, S.M.: NM+AS+MS-WeM6, **1**

— K —

Kamineni, V.K.: NM+AS+MS-WeM11, 1

— M —

Millette, J.R.: NM+AS+MS-WeM6, 1

— P —

Powers, K.W.: NM+AS+MS-WeM4, **1**