

CMOS to beyond CMOS, Novel Material Characterization Challenges

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Agenda

- (i) How does metrology affect your present work in nanomaterials?
- (ii) What questions relating to reliability of nanomaterials would you hope to see addressed in this workshop and report/roadmap?
- (iii) What metrology issues are of the most significance to you for your work in the coming 5 to 10 years?

Metrology and work in nanomaterials

- Intel pursues materials as part of “One Generation Ahead” strategies
- Key materials interest areas and recent publication areas: Novel substrates, transistor shrink enabling materials, interconnect materials, thermal dissipation advancement, cost effective packaging
- CMOS gate generational shrinkage $<0.65X$, pitch $<0.7X$
- Materials are more complex, take longer to fully assay and understand, growth area: increasing # of requests to the Intel labs
- “Characterization” requirements prior to new product ramps growing rapidly
- Fab instruments diverging more from Q&R lab equipment, need for more close collaboration between manufacturing development and materials characterization/metrology development
- Modeling is taking a greater role to control costs

Reliability in Nanomaterials and this Workshop

- Consensus on highest leverage metrology focus areas for the semiconductor industry
- Opportunities for metrology researchers from multiple disciplines to share learnings on common problems and approaches
- Identification of Potential Collaboration Opportunities between NIST, Universities and Industry

Metrology Needs Next 5-10 years

- **More focus on some key common problems, regardless of specific material/chemistry**
 - **Chemical and physical gradient characterization in complex matrices (ex. chemical amplification, molecular self assembly, complex surface modification agents, implant profiles, etc.)**
 - **Faster and higher resolution imaging/morphology techniques, SEM, AFM, TEM, novel ideas**
 - **Separation and purification capability (ex. chromatography, optical tweezers)**
 - **More In-line capable technique development**
 - **Particle size and morphology, dispersion, aggregation, correlation to materials performance**

Some Intel nanomaterials researchers

- Hok-kin Choi: Chemical Characterization Lab
- Robert Meagley: Molecular Self Assembly & Lithography
- Baohua Niu: Novel Precursors
- Fay Hua: Novel Metallurgy for Assembly and Integration
- Mansour Moinpour: CMP materials, dielectrics
- Mike Garner: MTO director, materials for novel devices