Materials Characterization in Nanodomains and Interfaces - Challenges and Opportunities

Sadasivan Shankar[1], Kevin Johnston[2], and Dan Herr[3]

[1]*Design and Technology Solutions, Technology and Manufacturing Group, Intel Corporation, Santa Clara, California*
[2]*Quality and Reliability, Technology and Manufacturing Group, Intel Corporation, Hillsboro, Oregon*
[3]*Semiconductor Research Corporation, North Carolina*

ABSTRACT

Over the past 3 decades the semiconductor industry has doubled the number of transistors on integrated circuits every 2 years, following an empirical law widely known as Moore's law. The ability of the semiconductor industry to stay on Moore's law has enabled the digital revolution and now the convergence of communications and computing. However, as the size of the smallest structures decrease, this has required the introduction of many new materials and the interactions of these heterogeneous materials and processing is increasing in complexity. With these decreasing dimensions, three factors become important; 1) Size to volume ratio is high leading to multi-material interactions, 2) sizes of nano-domains (such as grain boundaries) and devices become comparable, 3) interfaces or buried surfaces become dominant. The future of understanding these systems resides in modeling and metrology. This paper reviews some of the challenges in materials science and the opportunities for using fundamental characterization techniques to enable successful management of these heterogeneous interactions. As the industry evaluates new materials for future technologies, research is needed to develop new characterization techniques including modeling to evaluate nano-materials and materials with nano-scale dimensions and structure. Specific topics covered will include some technology problems, key metrology techniques such as NMR, nanoindentation, and modeling techniques such as quantum and atomistic methods.