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# Dimensional Metrology with Atomic Force Microscopy

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A quarter century has passed since the invention of atomic force microscopy (AFM) by Gerd Binnig, Christoph Gerber, and Calvin Quate, and AFM technology has undergone a proliferation virtually unprecedented in the four-century history of microscopic imaging techniques. Rapid commercialization of AFM technology over a wide spectrum in cost has led to a routine presence of AFMs from college teaching laboratories to analytical service providers and to widespread use in research ranging from materials science to cell biology. The variants of AFM imaging modes and contrast mechanisms are now far too numerous and diverse to be represented in a single conference or journal. Applications of AFM currently range from the metrology of lithographically patterned nanostructures to the imaging of living cells.

In the early 1990s, national metrology institutes (NMIs) in several countries began to develop AFM instruments that incorporated displacement interferometry to achieve intrinsic traceability to the International System of Units (SI) meter. Today, there are at least a dozen NMIs developing and practicing traceable AFM dimensional metrology.

The advent of critical dimension AFM (CD-AFM) also occurred during the nineties. This technology overcame the limitations of conventional AFM tips for imaging of near-vertical structures and brought AFM into the semiconductor fab as a support tool for manufacturing metrology. Two NMIs are now working with this AFM technology of this general type.

Several SPIE conferences have become important venues for researchers in specific application areas of AFM. The SPIE Advanced Lithography series (formerly Microlithography) is a major venue for research and development in semiconductor manufacturing. Metrology applications of AFM have thus been a thread in these conferences since the early nineties. More recently, the SPIE Scanning Microscopies conference and the NanoScience + Engineering conference have become venues for researchers involved in AFM dimensional metrology.

In this special section of the *Journal of Micro/Nanolithography, MEMS, and MOEMS* ($JM^3$), we are pleased to present updated versions of selected papers on AFM metrology from recent SPIE conferences. The majority of these papers were from the AFM sessions of the Scanning Microscopies 2011 conference in the SPIE Defense, Security, and Sensing symposium held in April 2011 in Orlando, Florida.

We want to thank all of the authors who contributed to this section for their interest in publishing their research here in $JM^3$. We also wish to thank all the reviewers of this special section for their support in reviewing the articles. We thank Dr. Burn J. Lin, Editor-in-Chief of $JM^3$, for allowing us the opportunity to act as the guest editors of this special section. Finally, we thank Brenda McDonald, Karolyn Labes, Rebecca Saxton, and the other SPIE staff for their support and assistance in organizing this special section.

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**Guest Editors**