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Presentation Title:

Understanding semiconductors and devices on the Nanoscale using Atomic Force Microscopy

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Abstract:

Developing next-generation semiconductors and devices poses significant challenges due to their complex dependence on many properties on progressing smaller length scales. Researchers and engineers need to characterize local electronic properties such as the conductance, work function, doping profiles or piezoelectric properties, and mechanical properties on the nm scale. Here, atomic force microscopy (AFM) is a well-established platform that offers a multitude of modes to measure such features. However, conventional AFM systems typically require hardware and cantilever changes for different modes, leading to potential inconsistencies in measurements and a loss of spatial correlation. Park Systems' FX series provides a unique solution by enabling correlative measurements of several electric characterization techniques such as conductive AFM (CAFM), Kelvin Probe Force Microscopy (KPFM), Piezoelectric Force Microscopy (PFM), or mechanical analysis – all on the same location without the need for setup adjustments or cantilever changes. Moreover, Scanning Capacitance Microscopy (SCM) and Scanning Microwave Impedance Microscopy (sMIM) are especially useful for device characterization and failure analysis of MRAMS, MOSFETs, or transistors, as these techniques enable investigation of local doping profiles.

In this talk, we showcase a set of exemplary measurements on semiconductors and devices with a focus on SCM and sMIM measurements. We demonstrate how a microwave resonator circuit connected to the cantilever enables measuring local doping profiles even on electrically floating devices and structures. This presentation underscore AFM's capability as an ideal tool for in-depth electrical characterization of many key functional parameters on a nm scale.