

Enhanced Spatial Resolution Electrical Scanning Probe Microscopy Using Carbon Nanotube-Terminated Tips

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ABSTRACT

Electrical scanning probe microscopes, such as the scanning capacitance microscope (SCM) for two dimensional dopant profiling, scanning Kelvin force microscope (SKFM) for surface potential measurements, and tunneling atomic force microscope (TUNA) for dielectric integrity measurements, are important tools for characterizing CMOS and nanoelectronic devices. A significant limitation of all these techniques is the terminal tip radius and the cone angle of the shank of the tip, which contribute substantial stray capacitance to the signal resulting in signal averaging over an area much wider than the terminal tip. To overcome this limitation, we have used conventional SPM tips terminated with a welded carbon nanotube (CNT). We have examined ultra-shallow junctions, high- κ gate stacks, low- κ intermetal dielectrics, and FinFET devices in cross-section with SCM and SKFM, using both conventional and CNT-terminated tips. We have also measured the electrical properties of the CNT-terminated tips. Spatial resolution improved substantially with the CNT-terminated tips compared to the conventional tips, but the CNT tips can introduce additional artifacts. We will present detailed comparisons of the two types of tips used for various SPM-based electrical characterization measurements that are useful for nanoelectronics.

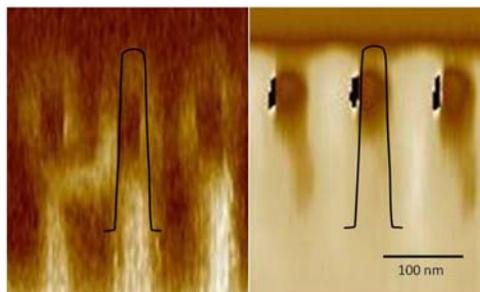


FIGURE 1. SCM images of 65 nm FINS measured with conventional (left) and CNT-terminated (right) tips.