Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Angstrom resolved imaging of charge percolation through the interface between phosphorous doped crystalline silicon and silicon dioxide[1]

KAPILDEP AMBAL, PHILIPP RAHE, CLAYTON C. WILLIAMS, CHRISTOPH BOEHME, Department of Physics and Astronomy, University of Utah, Salt Lake City, Utah — Using a high resolution ($\approx$100fm/$\sqrt{\text{Hz}}$ spectral noise density) scanning probe at T$\approx$4K, we measure currents through the interface between phosphorus doped ([P] $\approx 10^{17}$-10^{18} cm^{-3}) crystalline silicon and a native silicondioxide layer as a function of either the lateral cantilever position or the applied cantilever bias voltage (c-AFM imaging). These measurements visualize the percolation of charge through the interface and they show that local current maxima exist in patch-like structures of $\approx$30nm diameter, randomly distributed with an average distance between the centers of 30-40 nm. We associate these with P donor electron states. Within the patch-like structures, we observe additional, extremely localized ($\approx$5Å), current maxima. We associate those to silicon dangling bonds at the interface or within the silicondioxide. The hypothesized association of these very reproducible features is tested by current-voltage (I-V) measurements. For any randomly chosen surface position, these measurements reveal one of only four qualitatively distinct I-V responses, each of which is identified with charge percolation from P donors to the cantilever either with or without different kinds of silicon dangling bond involvement.

[1]We acknowledge support by the National Science Foundation, Major Research Instrumentation Program #0959328.

Christoph Boehme
Department of Physics and Astronomy,
University of Utah, Salt Lake City, Utah

Date submitted: 15 Nov 2013 Electronic form version 1.4