Moveable Quantum Dot Probe for Detecting Near-Surface Fixed Charges

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With nanoelectronics reaching the limit of atom-sized devices, it has become critical to characterize how irregularities in the local environment can affect device functionality. This includes unwanted charge defects detuning binary logic atomic patterns [1], delicately coupled quantum computing states [2], and supra-layer molecular electronics [3]. In this work, we characterize charged subsurface defects on a hydrogen terminated silicon (100) sample, adding a possible explanation for a heretofore contentious negatively-charged defect. Through contact potential difference maps, taken with non-contact atomic force microscopy, variations in the electrostatic topography on a nanometer length scale are shown and correlated with alterations in the behavior of dangling bond charge state transitions. In addition, the spectroscopic signature of a single electron charge transition in a dangling bond is used as a charge sensor to directly probe the depth of charged defects, the local Debye screening length, and the effective dielectric constant close to the surface.

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