Detection of Dielectric Trap States in Hafnium Oxide By Single Electron Tunneling Force Spectroscopy

DUSTIN WINSLOW, JON JOHNSON, CLAYTON WILLIAMS, Department of Physics, University of Utah — Atomic scale detection and imaging of electronic trap states in dielectric films has recently been demonstrated. Standard methods typically provide characterization over a much larger scale. Single Electron Tunneling Force Spectroscopy has been employed to measure the energy levels of trap states in HfO$_2$ with sub-nanometer spatial resolution. Analysis of individual spectra obtained at different locations shows variation in the density of defect states. When multiple spectra taken from 40 different locations are averaged, a broad peak 0.3 eV below the conduction band is observed, which agrees with data obtained over large areas by standard measurements. Additional peaks, not seen by the standard methods, are also observed. The method will be described and the data discussed.

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2J.P. Johnson et al, Nanotechnology 20 (2009) 055701