Abstract No. evan759

Interface Roughness Scattering and the Effective Mobility of an Inversion Layer

J. Yu, S. Goodnick, J. Grazul, M. Green, C.Y. Kim, K. Evans-Lutterodt, J. Lyding, W. Mansfield, D. Muller, T. Sorsch, R. Timp, G. Timp (U. of Illinois, Arizona State U., Lucent Technologies, and Agere Systems)

Beamline(s): X16B

Introduction: Improvement in the drive current performance is vital for scaling the MOSFET to sub-50nm gate lengths, but carrier scattering in the channel severely constrains it. The effective mobility, is one measure of the scattering in the channel. The mobility has been found to degrade universally according to ~ $E_{\perp}^{-x}$ law with x > 1, for a transverse field in the semiconductor larger than $E_{\perp}$ >0.5MV/cm. This dependence has been ostensibly attributed to interface roughness scattering, yet the correspondence between the roughness of the silicon/silicon dioxide interface and the mobility or drain current performance has never been established unequivocally. At least two parameters are required to characterize the interface roughness: 1. the Gaussian width of the asperity height distribution, and 2. the exponential decay length that characterizes the autocorrelation function along the interface. In addition to the X-ray diffraction for the interface characterization, we also use Scanning Transmission Electron Microscopy (STEM) and Scanning Tunneling Microscopy (STM). Here we show only the X-ray part of this effort.

Results: Shown are two different samples for the rms measurement in the top panel with rms values of 0.14nm and 0.25nm. In the bottom panel, we show transverse measurements from which we extract the in-plane correlation length, which we determine to be 3.4nm.

References: J. Yu, S. Goodnick, J. Grazul, M. Green, C.Y. Kim, K. Evans-Lutterodt, J. Lyding, W. Mansfield, D. Muller, T. Sorsch, R. Timp, G. Timp , IEDM 2001.