Abstract Submitted
for the MAR08 Meeting of
The American Physical Society

High Frequency Piezoresponse Force Microscopy in the 1-10 MHz Regime KATYAYANI SEAL, STEPHEN JESSE, BRIAN RODRIGUEZ, ARTHUR BADDORF, SERGEI KALININ, Oak Ridge National Laboratory — Imaging mechanisms in Piezoresponse Force Microscopy (PFM) in the high frequency regime above the first contact resonance are analyzed. High operation frequencies are expected to provide several advantages including (a) higher signal to noise ratios due to a larger number of oscillations per pixel time and increased separation from the $1/f$ noise corner (b) imaging at cantilever resonances with an associated increase in mechanical signal amplification (c) inertial stiffening of the cantilever that minimizes the non-local electrostatic force contribution to the signal and improves tip-surface contact. Furthermore, high frequency operation is an essential component of the PFM-based ferroelectric data storage systems, currently limited by the bandwidth of electromechanical detection (1-10 kHz). At the same time, operation at a high mode number can give rise to several problems, including the (a) response averaging due to the finite size of the cantilever beam (b) loss of sensitivity if the tip-surface spring constant becomes smaller than the effective spring constant of the cantilever and (c) signal loss due to the bandwidth of the photodetector. Analytical expressions for these limits are considered. We analyze the operation mechanisms in PFM at high frequencies, and demonstrate high quality PFM imaging at 1-10 MHz. Prospects for imaging in the 10-100 MHz range are explored.

Katyayani Seal
Oak Ridge National Laboratory

Date submitted: 27 Nov 2007 Electronic form version 1.4