Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Multi-frequency amplitude modulated non-contact atomic force microscopy for nanoscale dielectric measurements[1] BHARAT KUMAR, JOSEPH BONVALLET, SCOTT CRITTENDEN, University of South Carolina
— Multi-frequency non-contact atomic force microscopy with amplitude feedback in air was used to obtain the dielectric constant of ultra-thin films on metallic substrates. The cantilever was excited at its second bending mode by applying an AC electric field between the substrate and cantilever. The capacitance gradient between the cantilever tip and sample substrate was obtained by measuring the capacitive force driving the cantilever at its second bending mode. An analytic expression relating capacitance and dielectric constant of thin film was then used to fit the experimental data and the dielectric constant was obtained from the fit parameters. The method was validated by obtaining the dielectric constants of self-assembled monolayers of thiol molecules (2.0 ± 0.1) on gold substrate, and sputtered SiO_2 (3.6 ± 0.07) thin film. The high Q-factor of the second bending mode of the cantilever increases the accuracy of capacitive measurements while the low applied potentials minimize the likelihood of variation of dielectric constants at high field strength and of damage from dielectric breakdown of air.

[1]Acknoledgements: Army Research Office, grant W911NF-08-1-0387

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Date submitted: 11 Nov 2011 Electronic form version 1.4