Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Dielectric relaxation studies of ion diffusion into low-k dielectrics
ARCHANA RAJA, Columbia University, New York, NY, THOMAS SHAW, ERIC LINIGER, FEN CHEN, ALFRED GRILL, IBM T. J. Watson Research Center, Yorktown Heights, NY, United States, JUAN BORJA, Rensselaer Polytechnic Institute, Troy, NY, United States, GRISELDA BONILLA, IBM T. J. Watson Research Center, Yorktown Heights, NY, United States, JOEL PLAWSKY, Rensselaer Polytechnic Institute, Troy, NY, United States, TONY HEINZ, ROBERT LAIBOWITZ, Columbia University, New York, NY — High speed interconnects in advanced integrated circuits require ultra-low-k dielectrics to reduce the RC time constant. Reduction of the dielectric constant in these films is typically achieved via incorporation of nanopores in materials containing silicon, carbon, oxygen and hydrogen (SiCOH). Trap states build-up as dielectric breakdown is approached and increased leakage is observed. To understand the mechanism of breakdown we study nanoporous SiCOH films of k=2.4 to 2.7 primarily using dielectric relaxation. Dielectric films, in the thickness range of 40 nm, are incorporated into interwoven capacitor structures. To quantify dielectric relaxation in the pre-breakdown regime, capacitance and dielectric losses are determined as a function of frequency and temperature. Through these dielectric measurements, we have obtained activation energies in the range of 0.1-0.2 eV for humidified and annealed capacitors; and 0.9-1.2 eV for copper ion incursion into the dielectric. We also deduce a charge center density of $10^{15}/\mathrm{cm}^3$. Our measurements provide an estimate of the impurity content and changes in activation energy with annealing and other fabrication parameters.

Robert Laibowitz
Columbia University, New York, NY

Date submitted: 14 Nov 2013 Electronic form version 1.4