Temperature and thickness dependent dielectric propertiees of $(Ba,Sr)TiO_3$ thin film capacitors with Pt or IrO_2 electrodes

Cheol Seong Hwang, Woo Young Park, Doo Seok Jeong, and Jung-Hae Choi

School of Materials Science and Engineering and Inter-university Semiconductor Research Center, Seoul National University, Seoul, 151-742, Korea

This study investigated the structural and electrical properties of $(Ba,Sr)TiO_3$ (BST) thin film capacitors with thicknesses ranging from 20 to 215 nm, which were prepared by on- and off-axis rf magnetron sputtering technique on Si substrates. The electrodes are Pt or IrO_2 thin films. The deposition rate and cation composition ratios of the films were controlled to be the same regardless of the sputtering geometry. All the films show elongations in the out-of-plane lattice spacing suggesting the presence of compressive stress with a smaller value by the on-axis sputtering than the ones by the off-axis system. There was no thickness dependence of the strain in the polycrystalline BST films. The BST films deposited using the on-axis system showed a higher bulk dielectric constant with a higher interfacial capacitance and a lower leakage current level than the films produced by the off-axis system. The variations in dielectric properties of the films with the various thickness were measured as a function of temperatures ranging from 80K to 600K. The phase transition and Curie-Weis behaviors were critically dependent on the film thickness when Pt electrodes are adopted. The critical temperature decreases with decreasing film thickness. However, almost no temperature dependency was observed from the BST films with the IrO_2 electrodes. The thickness- and interface-dependent properties are discussed using the phenomenological thermodynamic theory in order to explain the correlation between the surface and strain effects and dielectric properties.