[Invited]

Doped Hi-K ALD Films of HfO_X and ZrO_X for Advanced Ferroelectric and Anti-Ferroelectric Memory Device Applications

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The discovery of ferroelectricity in doped hafnium oxide has generated excitement in the solid-state device community in recent years since hafnium oxide is a relatively simple oxide compared to traditional perovskite-based ferro-/anti-ferroelectric materials, and hafnium oxide is already used widely in the semiconductor industry. The discovery has inspired many researchers to study the system in further detail in the past few years. Recently, this group has discovered the ability to obtain anti-ferroelectric ZrOx in as-deposited ALD films alone, without the need for capping metallic electrodes or any post-deposition/post-metallization annealing. Tunability of the anti-ferroelectric behavior of ZrOx is also demonstrated using lanthanum doping and is corelated to changes in unit cell tetragonality with lanthanum doping. Process methods, including precursor delivery schemes and ALD deposition schemes, used to deposit doped HfOx and ZrOx-based ferroelectric and anti-ferroelectric films will be described in detail. Structural and electrical properties of such films will be described in detail and corelated.

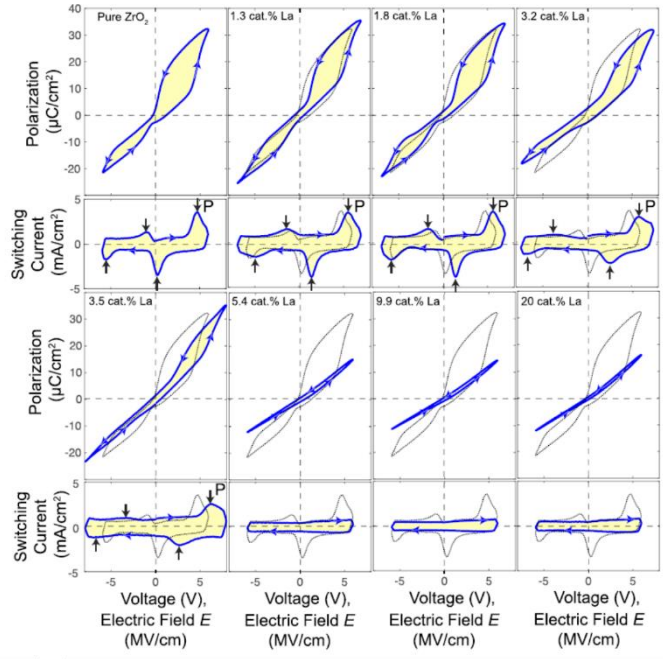

Figure 1 Tunability of anti-ferroelectricity in a ZrOx based stack deposited by Eugenus ALD. The plots show the evolution of polarization-voltage/electric field hysteresis and switching current-voltage/electric field as a function of lanthanum doping.