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ORAL PRESENTATIONS

3-O1. Isovalent and aliovalent co-substituted perovskite-type alkaline earth metal titanate dielectric thin films

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Barium strontium titanate (Ba, Sr)TiO_3 (BST) thin films have been widely investigated both for high density capacitor applications and for tunable capacitor applications due to their high dielectric constant and the large dielectric tunability. Low resistivity electrode materials are important for the device small equivalent series resistance (ESR), and they also influence the BST film growth and its properties. Obtaining intrinsically low dielectric loss BST films that also have high dielectric constant and low leakage current at the same time had not been widely investigated.

Polycrystalline nanograin size (Ba,Sr)$TiO_{3-\delta}$ thin films have been prepared with 5–10 mol.% of simultaneous A-site donor and B-site acceptor dopants from chemical solution deposition (CSD) precursor solutions on a single crystal Si or sapphire substrates with thin film metal electrode [1]. The BST films are rapidly thermally annealed in low oxygen partial pressures (P_{O_2}) atmospheres without the use of reductive conditions at 650 to 800°C to allow formation of very low dielectric loss films. The textural and surface characteristic properties of the A-/B-site co-doped $ABO_{3-\delta}$ thin films are studied by FE-SEM analysis, atomic force microscopy (AFM), transmission electron microscopy (TEM), electron energy-loss spectroscopy (EELS), and glancing-angle XRD.

Combination of selected isovalent and aliovalent substitution species produce low loss, low leakage current (high insulation resistance) thin film material with relatively high dielectric constants and voltage tunabilities. It is worth noting that the required dopant concentrations compensating for oxygen non-stoichiometry in the dielectric films are substantially greater than predicted by bulk equilibrium thermodynamic considerations. This observation is rationalized in the context of an oxygen defect model [2] with differences in the mobility and the concentration of electronic defects per grain boundaries vs. grain interiors, as well as in terms of dopant controlled rate of oxygen diffusion through the BST film [3].

References

1. Ch. Wenger et al., Materials Science in Semiconductor Processing 5 (2002) 233.
2. D. M Smyth, Current Opinion in Solid State and Materials Science 1 (1996) 692.
3. Denk et al., J, Amer. Ceram. Soc. 80 (1997) 279.