Oxide charge and band alignments in Pt/epi-Lu₂O₃/Si (111) structures studied by Internal Photoemission and C-V measurements

W. CAI, J.P. PELZ, Ohio State Univ., C. ADAMO, D.G. SCHLOM, Pennsylvania State Univ. — A variety of rare-earth/transition metal oxide films (of interest as possible “high-k” gate dielectrics for future MOS devices) were found to have similar band gap and band alignments to Si, and “tailing” conduction band (CB) states extending ~1 eV below the “primary” CB [1]. We used internal photoemission/photoconductivity (Int-PE/PC) and capacitance-voltage (C-V) measurements to study 20 nm-thick epitaxial Lu₂O₃ film grown at 700 °C on Si(111). A ~1.5V difference between the oxide- and Si-flat band voltages (measured by PC and C-V respectively) indicates ~6 x 10¹² cm⁻² fixed positive oxide charge, which was mostly removed by a ~350 °C post-metallization vacuum anneal. Int-PE measurements indicate the CB measured from the metal-side lines up ~0.4 eV below the “primary” CB measured from the Si side, in contrast with our finding on Pt/epi-Sc₂O₃/Si (111) [2] that the metal-side CB aligned with the tail-state CB. Also, Ballistic Electron Emission Microscopy of Pt/epi-Lu₂O₃/Si (111) found ~0.3 - 0.4 eV higher energy barrier than found by Int-PE, suggesting significant transient charge trapping in this sample. Work supported by NSF Grant No. DMR-0505165. [1] V. V. Afanas’ev et al., Appl. Phys. Lett. 85, 5917 (2004); 88, 032104 (2006). [2] W. Cai et al., Appl. Phys. Lett. 91, 042901 (2007).