Dielectric Interfaces
Room Bansal Atrium - Session DI-MoP
Dielectric Interfaces Poster Session I

DI-MoP-1 Dielectric Lifetime Enhancement of in-situ MOCVD Al_2O_3 on β-Ga_2O_3 Using Temperature Modulated Deposition*, **Saurav Roy**, A. Bhattacharyya, C. Peterson, S. Krishnamoorthy,* University of California Santa Barbara

We report on the growth and characterization of in-situ Al_2O_3 on (010) β-Ga_2O_3 deposited using metalorganic chemical vapor deposition (MOCVD) to enhance the dielectric quality and lifetime. The growth of Al_2O_3 is performed after the growth of β-Ga_2O_3 without breaking the vacuum in an Agnitron MOVPE reactor using Trimethylaluminum (TMAl) and Oxygen as precursor gas. The interfacial dielectric layer (First 5nm) is grown at 800 °C to crystallize the interface to have reduced interface trap density and the rest of the dielectric (17nm) is grown at 600 °C. Grazing incident Xray diffraction analysis was performed, and polycrystalline inclusions were observed in the grown Al_2O_3 films. The dielectrics grown at 600 °C exhibited higher interface trap density (D_t=3.2×10^{12} cm^{-2}) and lower breakdown field (E_{BR}=6MV/cm) compared to the dielectric grown at 800 °C (E_{BR}=10MV/cm,D_t=5.4×10^{11} cm^{-2}) characterized using deep-UV assisted CV measurements and the current-voltage characteristics of the MOS capacitors. The temperature-modulated dielectric sample (interfacial layer grown at 800 °C, and the bulk dielectric grown at 600 °C) has higher breakdown strength (E_{BR}=7.7MV/cm) and lower trap density (D_t=1.1×10^{12} cm^{-2}) compared to the dielectric grown at 600 °C. This is possibly due to the interfacial crystallization of the hybrid dielectric due to the initial growth at higher temperature. Time dependent dielectric breakdown (TDDB) was also performed to characterize the long-term reliability of the grown dielectrics. From the Weibull distribution plots of the time to breakdown for four different TDDB stress condition, shape factor β>1 was extracted indicating good statistical uniformity and intrinsic breakdown behavior. The TDDB distribution is much tighter (higher β value) for the 600 °C dielectric, compared to the 800 °C grown dielectric. This is possibly due to the short-range ordering of the 800 °C dielectric compared to the 600 °C dielectric, which reduces the long-term reliability of the dielectric. However, for the hybrid dielectric, the time to breakdown is found to be much tightly distributed compared to both 600 °C & 800 °C dielectric. Based on the E-model, the lifetime of the 800 °C can be extended to 10 years if the dielectrics are stressed at 0.7MV/cm, whereas the hybrid dielectric can be stressed at 3.1MV/cm to have 10 years of lifetime. Thus although the static breakdown voltage and trap densities of the hybrid dielectric are a little inferior compared to the 800 °C dielectric, the long term reliability of the hybrid dielectric is much superior.

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