Progress in Novel Oxides for Gate Dielectrics And Surface Passivation of GaN/AlGaN Heterostructure Field Effect Transistors

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ABSTRACT

Both MgO and Sc_2O_3 are shown to provide low interface state densities (in the 10^{11} eV^{-1} cm^{-2} range) on n- and p-GaN, making them useful for gate dielectrics for metal-oxide semiconductor (MOS) devices and also as surface passivation layers to mitigate current collapse in GaN/AlGaN high electron mobility transistors (HEMTs). Clear evidence of inversion has been demonstrated in gate-controlled MOS p-GaN diodes using both types of oxide. Charge pumping measurements on diodes undergoing a high temperature implant activation anneal show a total surface state density of $\sim 3 \times 10^{12}$ cm^{-2}. On HEMT structures, both oxides provide effective passivation of surface states and these devices show improved output power. The MgO/GaN structures are also found to be quite radiation-resistant, making them attractive for satellite and terrestrial communication systems requiring a high tolerance to high energy (40MeV) protons.