Radiation Tolerant Wide Bandgap Microelectronics

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Abstract:

Wide bandgap (WBG) electronic materials such as Gallium nitride (GaN) and beta phase Gallium oxide (β-Ga2O3) have recently attracted interest for their increased performance in highpower, high-frequency applications when compared to traditional Silicon microelectronics. Another advantage of WBG semiconductor materials is that they are less susceptible to displacement-induced degradation and can tolerate high temperature conditions. In this work, we experimentally demonstrate β-Ga2O3 and GaN fin field-effect transistors (FinFETs) that have inherently better tolerance to displacement-induced defects. The effects of displacement damage on transistor electrical characteristics were modeled in Silvaco TCAD, a physics-based electronic device simulator. Fin device geometries in which the gate wraps around the transistor channel were shown to be more robust to the effects of displacement-induced acceptor-like electronic states in the bandgap. Cleanroom processflowsfor fabricating FinFET devices with both β-Ga2O3 and GaN were developed. Electrical characterization of the devices shows promising direct-current (DC) output characteristics including high current-density and low sheet-resistance.