Reliability Limitations from Crystal Defects in Thick GaN Epitaxial Layers for Power Electronics

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The state-of-the-art power switching devices made from GaN semiconductors contain a high density of crystal defects, especially in the thick epitaxial layers. Most of these defects are present initially in starting wafers and some are generated during device processing. There is little conclusive evidence so far on the exact role that the crystal defects play on device performance, manufacturing yield, and more importantly, long-term field-reliability especially when devices are operating under extreme stressful high voltage environments. This paper provides the progress of characterization of thick GaN power semiconductor material epitaxial layers and growth technology, and the potential impact crystal defects may have on high-density power switching electronics. A comparison of the SiC development and manufacturing evolution is made to draw a parallel between SiC and GaN wide bandgap (WBG) semiconductor power electronics.