

High-Performance III-N Devices and Integration Technologies for Advanced System Applications

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Abstract:

Gallium Nitride (GaN) and related III-N materials offer the promise of exceptional levels of performance for RF, microwave, and mm-wave applications, as well as for power conversion and control. This outstanding performance potential is due in large part to the combination of a large band gap with high critical electric field, high carrier mobility and saturation velocity, and the effects of spontaneous and piezoelectric polarization that enable high sheet carrier concentrations to be achieved without extrinsic doping. These features have led to remarkable device performance, ranging from devices with f_i/f_{\max} near 500 GHz in ultra-scaled HEMTs to high-power, high-voltage rectifiers and transistors capable of handling voltages well above 1500 V and 10 A by using vertical device architectures on bulk GaN substrates. For these devices to have maximum system-level impact, however, heterogeneous integration with Si-based electronics and compatibility with advanced packaging platforms is needed. In this talk, recent demonstrations of high-performance GaN-based devices for RF through mm-wave applications, as well as for power conversion and control will be described, and novel advanced processing techniques that promise to enable these devices to be heterogeneously integrated with Si and advanced packages while retaining the unsurpassed performance possible with GaN will be discussed.