

Ultra-Wide Bandgap MMW/sub-MMW Devices

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ABSTRACT

The U.S. Army Ultra-wide Bandgap RF Electronics Center is a multidisciplinary basic research center in electronics, semiconductor physics, and materials science for exploring ultra-wide bandgap (UWBG) devices and materials capable of operating under extreme frequency, power, and thermal conditions. It was created to facilitate collaboration between extramural academic researchers and the Army in pursuit of a mutual goal: generating the foundational knowledge in solid-state physics, device structures, integrated circuit design, materials discovery and development, and physics-based machine learning needed to enable the next generation of RF electronics based on UWBG semiconductors and related emerging materials with unprecedented power, bandwidth, frequency agility, and size-weight-and-power (SWaP) requirements.

An explicit goal of the Center is to enable an order-of-magnitude or greater increase in power density over current state-of-the-art (SoA) devices based on wide bandgap (WBG) materials like gallium nitride (GaN), particularly in the upper millimeter-wave/submillimeter-wave regions (90-1000 GHz) of the EM spectrum. Device structures at these frequencies are smaller because of size scaling, and therefore provide an ideal platform for understanding complex carrier dynamic under extremely high electric field and the associated breakdown mechanism in UWBG semiconductors without being overwhelmed by thermal issues. At these frequencies, device modelling for predicting device performance must include complex nonlinear coupling of physics-based carrier transport, thermal effects, and full-wave electromagnetics. This knowledge is necessary for fully realizing the potential of UWBG semiconductors for future high power RF electronic applications. The presentation will provide an overview of the Center as well as recent results by extramural performers.