Ultrafast Studies of Nonradiative Processes in Wide Bandgap Semiconductors

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In this program, we will develop and apply unique ultraviolet ultrafast time-resolved spectroscopy techniques to study carrier density dependent nonradiative recombination (NRR) processes and the dynamics of corresponding hot carriers produced in these processes in wide and ultra-wide bandgap (UWBG) semiconductors. The goal of this work is to validate theoretical models of NRR processes in GaN with systematic studies quantifying both traditional and trap-assisted Auger-Meitner recombination (TAAMR) in (U)WBG semiconductors as a function of carrier density. This work will enable the development of novel experimental tools to interrogate carrier dynamics and ultrafast heat generation, which will provide an avenue for addressing key scientific questions surrounding AMR processes in (U)WBG semiconductors. These questions include the rates of TAAMR, identifying the properties which impact the rates, the role of TAAMR in ultrafast heat production, and the detection of hot carriers, especially hot holes. NRR, specifically TAAMR, limits the performance of (U)WBG semiconductors and devices. Advancements will inform design and modeling of the next generation of (U)WBG power and optoelectronics devices operating at the high carrier densities relevant to demanding DOW applications.

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