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**SAMPLE ABSTRACT**

Understanding material properties at nanometer-length and picosecond-time scales

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Technologies needed to solve problems in climate change, energy security, and quantum information rely on a fundamental understanding of novel nanomaterials. Next-generation tools that can probe and manipulate the optical, electronic, and physical properties of nanomaterials at sub-picosecond time scales and nanometer length scales will enable new nanodevice architectures. We have developed a laser coupled scanning ultrafast electron microscope that incorporates cathodoluminescence, photoluminescence, and electron-beam-induced deposition in a single user tool. This tool provides the required high spatial and temporal resolutions and meV spectral resolution at temperatures from 8-300 K. I will describe our recent explorations of near-field plasmon interactions in nanopatch antennas and plasmonic oligomers. Further, I will present the nanoscale energetics of grains and defects in hybrid perovskites and CdSe photovoltaic devices. Lastly, I will describe combined picosecond-pulsed electron and laser beam experiments that enable nanometer scale investigations of carrier diffusion and dynamics, greatly surpassing the optical diffraction limit associated with conventional time-resolved spectroscopies. The cathodoluminescence and pulsed electron beam experiments were conducted at the Center for Nanophase Materials Sciences (Oak Ridge National Laboratory), which is a DOE Office of Science User Facility.

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