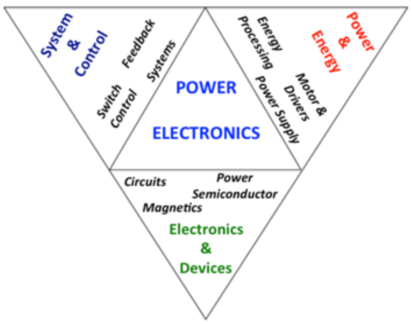
Overcoming Defects in Electronic Devices under High Voltage Environments

Prof. Aris Christou, 301-405-5208, christou@umd.edu



Abstract. This review presentation focuses on presenting the fundamental understanding of the role of crystal defects in semiconductors and dielectrics under high voltage environments as well as high-temperature, high electric and magnetic fields, intense radiation and mechanical stresses. The emphasis is whether defects are show stoppers preventing the realization of the enormous potential for advanced energy applications that will conserve energy. Radically new material synthesis and characterization techniques with atomic-level control that lead to dramatic reductions in bulk and interface defects are needed for materials operating within these extreme environments. This will require real-time *in situ* material characterization during material synthesis and when the material is subjected to extreme environmental stress. Beyond high voltage operation, such material improvement with reduced density of defects represents a fundamental breakthrough that will enable semiconductors and, namely, wide band-gap (WBG) semiconductors, to reach full potential. The main emphasis of our research is to understand defect dynamics in WBG semiconductor bulk and at interfaces during the material synthesis and when subjected to high power applications. More than a 100-fold reduction in defect density compared to the current state-of-the-art will be achieved using novel material synthesis techniques to ensure widespread usage of WBG semiconductors for energy-efficient applications. The device architecture necessary to achieve success is the vertical power transistor. Results of the achieving low defect density and reliable vertical FETs will feed into several other energy initiatives. These initiatives include: (1) advanced nuclear energy systems, (2) clean and efficient combustion of 21st century transportation fuels, (3) electrical energy storage, (4) the hydrogen economy, (5) solar energy utilization and (6) solid-state lighting.

Presenter. Prof. Christou and his graduate students conduct research in Wide Band gap semiconductor materials for Power Electronics. His research in power electronics materials, devices and systems encompasses manufacturing and process science, extreme environments, and radiation effects in energy materials and devices. Professor Christou' group has also made significant contributions in photonic materials and devices, and optoelectronic device and component reliability. The third area of research which Professor Christou leads is in devices and materials for flexible displays. The emphasis has been on developing graphene interconnects for flexible electronics as well as investigating the mechanical, optical and electrical properties of graphene on polymer substrates. As one of the pioneers in compound semiconductor devices, Professor Christou has over 250 publications and has authored and edited six books in the area of device technology and device reliability. You may read more about Professor Christou at: www.christou.umd.edu.