Materials, Components and Devices for Electrical Energy Systems

Elena Guliants and Guru Subramanyam
Center of Excellence for Thinfilm Research and Surface Engineering (CETRASE)
Department of Electrical and Computer Engineering
University of Dayton
300 College Park, Dayton, OH 45469-0232
gsubramanyam1@udayton.edu

University of Dayton (UD) has been actively engaged in materials, components and devices for electrical energy systems for a very long time. Key areas of research at UD are portable power, high temperature components, high power SiC devices, and most recently GaN power devices. With the opening of General Electric's (GE) newest Electric Power Integrated Systems (EPIS) Center in our campus, we are developing undergraduate and graduate curriculum to train students in Electrical Energy Systems. The Electrical Energy Systems concentration will include courses in Contemporary Power Systems, Power Electronics and Smart Grid. GE, Regal Beloit, Globe Motors, Delphi, Dayton Power & Light and Goodrich Aerospace are some of the companies that will benefit from our graduates trained in the area of Electrical Energy Systems.

In the area of Power Semiconductor Devices, UD has collaborated with Air Force Research Laboratories (Power Division of Propulsion Directorate/AFRL/WPAFB) and industry (Cree, Inc.) to develop a novel technology which combined robust SiC-based power electronics with optical communication networking as part of the "Fly-by-Light" DoD initiative. Devices fabricated on epilayers of 3C- and 4H-SiC, a wide bandgap semiconductor that is extremely attractive for high power devices by supporting voltage levels at least ten times (blocking voltage of up to 5000V) and operating temperatures six times higher than silicon, demonstrated much higher levels of output current and power without overheating, as well as strong immunity not only to elevated temperatures, but to pressures, mechanical shock, vibration, chemically aggressive environments and humidity. In NPN BJTs in the common emitter Darlington pair configuration, MOSFETs, and IGBTs that were modeled and fabricated in our research, an optical signal was sent via fiber from a light source replacing the control electrical signal in electronic devices. Such optical control permits ultra-fast signal transmission over low-loss fiber optic networks which possess the properties that are far superior to those of electrical circuits, including immunity to electromagnetic interference (EMI) in navigation control systems.

We are also currently engaged in high power handling devices, components for RF/microwave applications in collaboration with AFRL Sensors Directorate. UD is also a leader in ceramics, and composite materials, for high temperature components, key for automotive, aerospace and space applications. UD's Nano Engineering Science and Technology (NEST) center includes a clean room with processing, advanced characterization and packaging capabilities. Our research group also has access to the AFRL's world-class research facilities including a 0.25 µm GaN process currently available.