Advanced Metrology of Electronic Devices in Operating Mode Inside the Scanning Transmission Electron Microscope

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Zoom Link: https://purdue-edu.zoom.us/j/98487769216

Abstract:

Transmission electron microscopy (TEM) excels at determining the physical structure and composition of samples down to the atomic scale. But device operation often involves electronic changes that do not coincide with any significant physical changes (*e.g.*, gate biasing, driving a current, or storing charge). As a result, the processes underlying function and failure in electronic devices are often difficult, if not impossible, to detect in TEM. Scanning TEM electron beam-induced current (STEM EBIC) imaging provides high-resolution *electronic* contrast as a complement to TEM's physical contrast. EBIC, generally, involves the measurement of current generated in a sample as it is scanned with an electron beam. It has been used to map electric fields in devices since the 1960’s and is typically performed in the scanning electron microscope (SEM). Recent advances in measurement sensitivity and sample preparation have rejuvenated the field of STEM EBIC, leading to the demonstration of new EBIC modes, atomic resolution EBIC, and *operando* STEM EBIC. In this presentation I will discuss different modes of current generation, compare SEM and STEM EBIC, and demonstrate STEM EBIC mapping of various electronic properties, including conductivity. I will then present examples of advanced STEM EBIC characterization of operating electronic devices ranging from modern commercial semiconductor components to next-generation memory systems.

Bio:

William A. Hubbard received a BS in physics and mathematics from Boston University in 2008, after which he worked as a research assistant in the Harvard University Physics Department until 2010. He received his PhD in experimental condensed matter physics in 2017 from UCLA, where he was then a postdoctoral scholar until 2019. From 2018 to 2021 he also held a casual appointment as a member of the technical staff at the Aerospace Corporation. Since 2020 he has been the CEO of NanoElectronic Imaging Inc. (NEI), where his research focuses on developing electron microscopy-based techniques, such as STEM EBIC, that can visualize electronic and thermal contrast in operating nanodevices.

Host: Dr. Rosa E. Diaz (rdiazri@purdue.edu)