DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering,

Thesis Defense Presentation

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Direct Detection Electron Energy Loss Spectroscopy: Characterization and Applications

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Abstract: Electron energy loss spectroscopy (EELS) is a powerful characterization technique which provides an unparalleled combination of nanoscale spatial resolution along with elemental and chemical sensitivity. Unfortunately, EELS measurements often suffer from low signal to noise ratio (SNR) and poor energy resolution, preventing the analysis of many materials. In large part, these limitations are due to the electron detection process, which is conventionally achieved with an indirect detection method. In this thesis, we adopt a new generation of electron detection – a direct detection (DD) sensor operated in electron counting mode – for EELS. We perform a quantitative comparison between conventional and DD EELS, and we find that DD offers significant improvements in SNR and energy resolution (at a given field of view). We then apply DD to several EELS applications that are impractical or impossible with conventional equipment: low-dose mapping of beam sensitive polymer nanomaterials; time-resolved in situ measurements of surface chemistry in a 2D material; and extended edge fine structure analysis of high energy (>5 keV) edges. This thesis establishes DD EELS as a state-of-the-art technique for core-loss EELS where SNR and resolution must be maximized.