doi:10.1017/S1431927622009631
Microsc. Microanal. 28 (Suppl 1), 2022

High Resolution Electron Energy-Loss Spectroscopy for the Study Organic and Biological Systems in the Scanning Transmission Electron Microscope

David W. McComb[1,2]*

[1.] Center for Electron Microscopy and Analysis, The Ohio State University, Columbus, OH, USA
[2.] Dept. of Materials Science & Engineering, The Ohio State University, Columbus, OH, USA
* Corresponding author: mccomb.29@osu.edu

The drive to characterize chemistry, structure and bonding with high spatial resolution has driven the exciting developments in electron energy-loss spectroscopy (EELS) in the scanning transmission electron microscope (STEM) over the last two decades. This has been achieved with the development of high-performance electron monochromators, improved spectrometer electron optics and introduction of new detectors with a high detector quantum efficiency (DQE). [1] For example, using a STEM equipped with a thermally assisted field emission source enables EELS to be performed with an energy resolution (ΔE) in the range 0.5-0.8eV as measured by the full width half maximum (FWHM) of the zero-loss peak in the spectrum. Introduction of a commercially available monochromated instrument at the turn of the century enabled $\Delta E<0.2$eV. [2]. While subsequent improvements in electronics and electron optics delivered incremental advances, it was the introduction of the α-design that resulted in step change in performance. [3] This groundbreaking design initially delivered ΔE in 10-20meV range, but improvements in electron optics and detectors have enabled 4-6 meV to achieved on a number of instruments around the world. [1] This level of performance is opening up new opportunities for the study of both electronic and vibrational excitations using high resolution EELS in the scanning transmission electron microscope (STEM). One of the most exciting, and challenging, research opportunities for high resolution STEM-EELS is to probe the spatial distribution of functional groups in organic/ biological systems. In this contribution, I will discuss recent results in high resolution STEM-EELS from the literature as well as from my own research activities, focusing on how these capabilities have the potential to provide new insights in the study of organic, hybrid (organic-inorganic) and biological materials [4].

References:

[1] MJ Lagos et al, Microscopy **71**(S1) (2022), p. i174.
[2] P Tiemeijer et al, Microsc. Microanal. **8** (2002), p. 70.
[3] O.L. Krivanek et al., Philos. Trans. R. Soc. London, Ser. A **367** (2009), p. 3683.
[4] The author acknowledges financial support from a number of sources over the last two decades including Defense Advanced Research Projects Agency (DARPA), the Center for Emergent Materials at The Ohio State University, an NSF MRSEC (DMR- 2011876), the Air Force Research Laboratory (AFRL), the Air Force Office of Scientific Research (AFOSR) and the Engineering and Physical Sciences Research Council (EPSRC), as well as support from numerous industrial collaborators.