Quantitative and Qualitative Microanalysis of Organic Materials by NEXAFS Spectroscopy

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The emergence of synchrotron-based soft X-ray spectromicroscopy over the last 20 years has led to a wide range of microanalytical applications of Near Edge X-ray Absorption Fine Structure (NEXAFS) spectroscopy. In NEXAFS spectroscopy, the absorption of an X-ray leads to the excitation or ionization of a core electron; in organic molecules this leads to electronic transitions that are described using a 'core → π^*' and 'core → σ^*' description. With the development of zone-plate diffractive optics and stable imaging platforms,[1] NEXAFS can be routinely extracted from small (sub-35 nm) domains in soft materials. NEXAFS spectromicroscopy is analogous to Electron Energy Loss Spectroscopy (EELS), which can be acquired in a TEM with atomic resolution. However, as a resonant technique, NEXAFS has substantial advantages in terms of radiation damage.[2]

This presentation will review the *state of the art* of chemical microanalysis of organic materials through NEXAFS spectroscopy. The development of high energy resolution synchrotron beamlines and computational methods has extended NEXAFS spectroscopy to sophisticated approaches for chemical functional group analysis.[3] This includes chemical sensitivity to extended conjugation and intermolecular (π/π) interactions in organic electronic polymers.[4] New areas of exploration include disordered materials, such as molecular glasses.

With appropriate chemical insight, NEXAFS imaging can be extended to quantitative mapping of organic materials in 2 and 3 dimensions. Key applications in this area include fuel cell membranes, biomineralization phenomena, and chemical processes studied *in situ*. This presentation will also report on first results from the new cryo-STXM microscope at the Canadian Light Source, which was developed to examine radiation sensitive materials.[5]

The next generation of soft X-ray microscopes based on ptychographic imaging that surpass the limits of nanofabricated of diffractive optics and are realizing X-ray spectromicroscopy down to the 5 nm scale.[6] Further development of non-synchrotron sources, such as higher harmonic generation, may have the potential to bring soft X-ray spectromicroscopy from the synchrotron to the basement laboratory.

References:

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