STXM investigations of biological tissues

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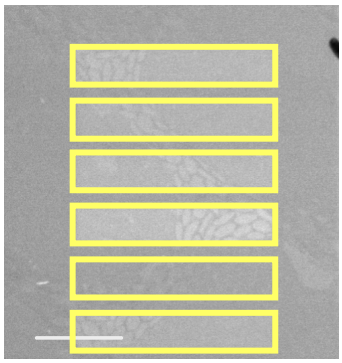
In contrast to the conventional use of scanning transmission x-ray microscopy as an analysis tool for materials, especially extending to "soft materials", we have investigated some biological tissues to ascertain an alternative and promising avenue of the application of zone-plate based scanning x-ray microspectroscopy. As the number of x-ray microscopes worldwide increases, the technique should be able to augment the arsenal of techniques that could be of use to the biological community under suitable experimental conditions.

We have investigated several biological samples taking advantage of the polymer STXM at the Advanced Light Source. A set of experiments focused on the investigation of biological fibers, in particular the spectroscopic properties of spider webs. Preliminary energy dependent line scans across the fibers yielded no distinct dichroism mechanism and thus no direct evidence for a preferential orientation of the monomers. Another interesting biological area is the analysis of human hair. Although the lateral resolution in STXM (<35 nm at BL5.3.2) is currently about an order of magnitude higher than transmission electron microscopy (TEM), the resolution achieved was sufficient in recognizing the internal structure and morphology of human hair. However, no specific spectral signatures were distinguished which would have allowed identification of distinct chemical species.



A 20 x 20 µm² STXM image of a microtomed xanthopan eye recorded at the ALS 5.3.2 STXM (hν = 288.3 eV). The smaller rectangular areas were pre-recorded images which subsequently indicate different contrast enhancement that become amplified due to x-ray imaging on the same area of the sample.

Radiation damage or in-situ chemical changes due to the high photon flux density are often a disadvantage in x-ray microscopy. However, in some cases it may be advantageous as we have demonstrated for insect eyes. We have investigated microtomed samples from the rear part of the compound eye (taken from the moth xanthopan morgani praedicta). Scanning smaller areas with different photon energies (on-resonance, off-resonance) has yielded different contrast when scanning the sample on an absorption edge. Although the mechanism which causes the damage is not clearly understood and in particular not predictable, it should become a useful tool in x-ray microscopy in the foreseeable future.

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