

Séminaire SOLEIL

Applications of Scanning Transmission X-Ray Microscopes at the ALS

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Séminaires

Scanning x-ray transmission microscope (STXM) became during last few years an important tools in applying soft x-ray spectroscopy to many scientific disciplines. When STXM is placed on a modern beamline of the third generation synchrotron it allows for chemical characterization of materials and processes on 20 nm scale. It is a microscope, thus it produces images, but its strength is ability to do high quality spectroscopy on that scale.

In STXM x-rays are focused using a Fresnel zone plate and the sample is mechanically scanned in the zone plate focal plane. Transmitted x-rays are detected by a single element detector and the detector signal as a function of the sample position constitutes an image. Recording images at different x-ray energies around absorption edges of a given element allows obtaining spectroscopic information for each of image pixels.

At the Advanced Light Source there are three STXMs. One is placed on a bending magnet beamline and operates between 250 eV and 600 eV. The most versatile one is on the 11.0.2 beamline with an elliptically polarizing undulator as a source and operates between 80 eV and 2100 eV. This x-ray range covers absorption edges of most common elements. The third STXM is a portable microscope which can be used on many different beamlines.

Resolution of a STXM depends on the used zone plates. Current ALS zone plates can resolve details smaller than 20 nm. Samples preparation can be similar to that for a TEM, but because the sample can be at full atmospheric pressure of He (or air for some x-ray energies) they can be “wet”, fully hydrated, a huge advantage for biological or environmental sample studies.

The 11.0.2 STXM can take advantage of elliptically polarized light. Magnetic sensitivity is provided by the X-ray Magnetic Circular Dichroism (XMCD) effect of resonance x-ray absorption at the absorption edges. As such, it is an element specific magnetization measurement with high sensitivity. It is possible to measure a single monolayer of element with full spatial resolution. This is well illustrated in studies of ferromagnetic effect of carbon. Elemental specificity of the measurements allow on separate characterization of different layers in complex structures. By measuring a sample in few different orientations with respect to the x-ray beam it is possible not only to obtain a value of magnetic moment but also its direction on scale of 20 nm.

The x-ray beam has a time structure of bursts with a duration of 70 ps and frequency 500 MHz. Fast, direct x-ray photon detection using an avalanche photodiode results in about 100 ps time resolution of the measurements. The magnetization dynamics studies on sub-micrometer complex samples are one of the most unique applications of the STXM. Detail motion of vortex core under various excitations can be observed. Imaging of spin transfer switching gave new insights into a combined role of spin transfer and charge current in the switching process.

STXM found a very wide application in polymer science, where a high chemical sensitivity combined with a good spatial resolution and relatively low radiation damage makes it a very important tool in studies today’s complex polymers. Other common applications are environmental studies, especially of a role of bacteria.

In the talk will be discussed:

- Technical details of the STXM design which have most impact on the microscope performance.
- Examples of unique STXM application.

Formalités d'entrée : accès libre dans l'amphi du Pavillon d'Accueil. Si la manifestation a lieu dans le Grand Amphi Soleil du Bâtiment Central, merci de vous munir d'une pièce d'identité (à échanger à l'accueil contre un badge d'accès).

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