



Scientific Highlights from the Soft X-ray Spectromicroscopy (SM) Facility at the Canadian Light Source

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Canadian Light Source Inc., University of Saskatchewan, BIMR & McMaster University

Elliptically Polarizing Undulator

Front End

M1 mirror and POE

Monochromator M3PEEM M3STXM

Exit Slit

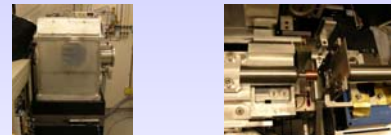
M4PEEM

STXM

STXM-Inside view

PEEM

PEEM-Energy Analyzer

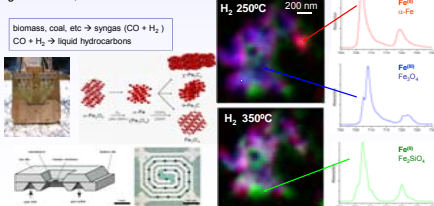


Materials Science

in situ Catalysis

Smit E. De. et al. *Ang. Chemie Int. Ed.* 48 (2009) 1-6.

- Fischer-Tropsch catalyst reaction examined under actual reaction conditions using a novel gas flow cell, heatable to 700°C.

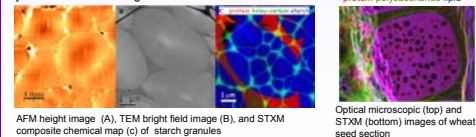


Life Science

Composition of Wheat Grain

Gaillard, C. et al. (INRA), Nantes, France.

- Comparison of AFM, TEM, and STXM in order to evaluate utility of STXM for seed research.
- Wheat seed section map shows protein/lipid in the aleurone layer, polysaccharides in the internal pericarp and sub-aleurone wall.
- Starch granule on holet carbon film shows protein/lipid layer around the starch granules.

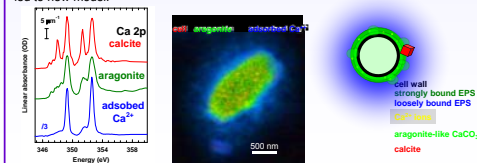


Environmental Science

CaCO₃ Biomineralization

Obst, M. et al. *Geochimica et Cosmochimica Acta* (2009) in press.

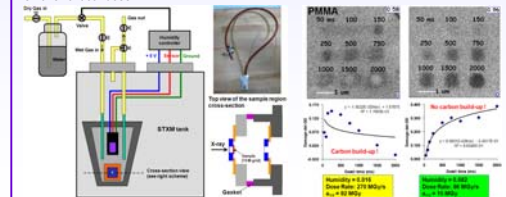
- Bacterial biomineralization is a major component of the carbon cycle.
- Understanding may assist development of bacterial mediated carbon sequestration schemes.
- Detailed studies of supersaturation, nutrient, pH dependence of CaCO₃ at cell surface led to new model.



Beamline and Recent Developments

Humidity Cell

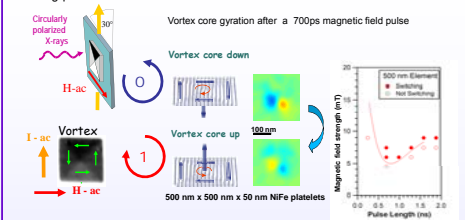
- Humidity control in situ soft X-ray spectromicroscopic analysis. **Jian, W. et al.**
- This cell can also be used to vary sample gas environment to oxidation or reduction.
- PMMA X-ray damage under humid environment shows almost no carbon build-up and smaller critical dose.



Time-resolved Magnetic Spectromicroscopy

Weigand, M. et al. *Phys. Rev. Lett.* 102 (2009), 077201 – (1-4).

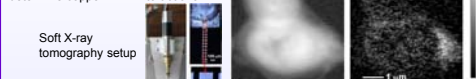
- Waeyenberge, B. Van. et al. 2008 CLS Activity Report (2009), 16-17.
- Fast vortex core reversal by short magnetic field pulses understanding & optimizing switching parameters.



Interaction of Copper with Yeast Nucleus

Harkness, T. Department of Anatomy and Cell Biology, UofS.

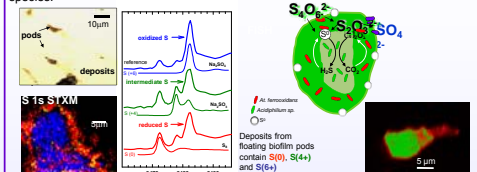
- STXM has been used to determine the feasibility to investigate metal labelling, and metal binding sites related to DNA and proteins.
- In this study, the binding sites of copper in the nucleus of yeast cell has been investigated. More work is being continued.
- With 3-D chemical imaging, a better and more accurate understanding can be achieved to localize copper accumulation yeast cells and to determine copper-DNA interactions.



Sulfur Metabolizing Co-operatives

Norlund, K.L.I. et al. *Envir. Science and Technol.* (2009) in press..

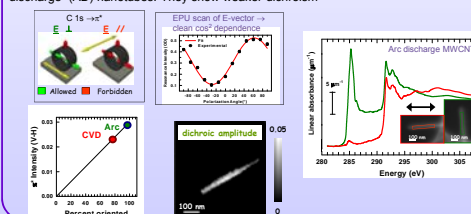
- Sulfur metabolism in Acid Mine Drainage (AMD) bacterial biofilms is poorly understood. It is a key aspect of their survival at low-pH and high [S].
- Understanding the mechanism may help optimize bio-remediation strategies.
- Additional STXM studies (S 2p, C 1s @ ALS) & fluorescent in situ hybridization (FISH) show complex synergy of oxidizing and reducing bacterial species by two symbiotic species.



Mapping Defects in Carbon Nanotubes

Najafi, E. et al. *Small* 4 (2008) 2279-2285.

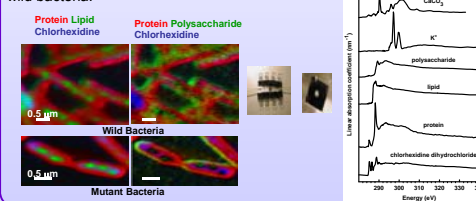
- Strong dichroic signal observed in individual multi-wall carbon nanotubes for the first time. Can this be used to map defects along a single carbon nanotube?
- Chemical vapor deposition (CVD) nanotubes are much more defective than arc discharge (AD) nanotubes. They show weaker dichroism



Chlorhexidine-tolerant and Chlorhexidine-sensitive *Delftia acidovorans*

Dynes J.J. et al. 2007 CLS Activity Report (2008), 104-105.

- Chlorhexidine is distributed in the centre of the bacteria.
- Chlorhexidine concentration was higher in the mutant bacteria than the wild bacteria.



Iron Oxidizing Bacteria

Miot J. et al. (2009) *Geochim. Cosmochim. Acta.* 73, 696-711.

- Bacteria are capable of oxidizing Fe(II) under anoxic conditions, which is a potential mechanism that was leading to large iron mineral deposits on our planet in the precambrium.
- The mechanisms of the Fe(II) oxidation and mineral precipitation are not fully understood.
- This STXM and TEM study showed that the nitrate-reducing Fe-oxidizer BOFEN1 (Acidovorax) oxidized Fe(II) in the periplasm, which finally results in an encrustation of the bacteria, whereas the phototrophic, anoxic Fe(II) oxidizer *Rhodospirillum rubrum* does not encrust.



Beamline Specification

- Source: Apple II type Elliptically Polarizing Undulator
- Monochromator: Plane Grating Monochromator
- Energy range: 150-2500 eV
- Energy resolving power: normal ~3000, can reach >10,000
- Polarization: Circular, linear from -90 to +90°
- Endstations:
 1. Scanning Transmission X-ray Microscope (STXM)
 2. Photoelectron Emission Microscope (PEEM)
- Flux: 10⁸ ph/s in <50 nm spot (STXM)
10¹² ph/s in 20 μm (PEEM)

For more information please contact the SM beamline team or visit the SM website at: <http://exshare.lightsource.ca/sm/Pages/SM-Home.aspx>

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