

## **X-Ray Imaging Technologies for Energy Storage**

Monday October 20th 2008.

Room 2-100B, Ground Floor, Bldg 2, Lawrence Berkeley National Lab

This workshop is aimed at looking for opportunities that synchrotron radiation research can provide to answer some of the challenges associated with Energy Storage. The workshop will most likely focus on battery technologies, the problems in this field and possible ways of examining these problems by means of the numerous techniques available via synchrotron radiation.

**10:00** Introduction - A.MacDowell and/or Vince Battaglia – Aim will be for the Battery people to describe the problems, the ALS people to describe the techniques. The outcome of the workshop is the ability to map problems onto techniques and fill in the appended chart.

**10:15** - Electrical Storage overview - Phil Ross (MSD, UCB (ex)) - where are batteries used? How are they going to be used in the future, technical challenges, how to solve, vision

**11:00** - Nitash Balsara (UCB) - use of SAX for study of nano structure in storage devices

**11:30** - Jordi Cabana-Jimenez (EETD, LBNL) - Battery work at NSLS Brookhaven, and future possibilities in the Bay Area

**12:00** - Aniruddha Deb (U. of Michigan) - Battery work at the APS

**12:30** : Lunch

**1:30**- Jeff Kortright (MSD, LBNL) - “Opportunities using soft x-rays to study battery materials and processes”

### **Description of ALS techniques**

#### **In situ Techniques**

**2:00** Alastair.MacDowell (ALS, LBNL) -u-XT Micro X-ray Tomography 8-60KeV

**2:10** Alex Hexamer (ALS, LBNL) -SAXS, Small angle X-ray scattering. hv=10KeV

**2:20** Nobomichi Tamura (ALS, LBNL) - u-XRD, micro X-ray Diffraction 10-23KeV

**2:30** Mathew Marcus (ALS, LBNL) -u-XAS Micro X-ray Absorption spectroscopy 3-14KeV

**2:40** T.Tyliszczak/D.Kilcoyn (ALS, LBNL) - STXM, Scanning Transmission X-ray Microscopy 200-650eV

**2:50** – Mike Martin (ALS, LBNL) FTIR, Fourier Transform Infra Red Spectroscopy.

#### **Surface techniques**

**3:00** – Andreas Scholl (ALS, LBNL) - PEEM, Photoemission Electron Microscopy 200-1000eV

**3:10** – Jinghua Guo/J.Denlinger (ALS, LBNL) - Surface Science 60-1200eV

**3:20** - David Prendergast (Theory group, Mol Foundary, LBNL) Simulation of the x-ray spectroscopy of materials.

**3:40**: Discussion with coffee break as required.

#### **Organizers**

Alastair MacDowell (LBNL) [aamacdowell@lbl.gov](mailto:aamacdowell@lbl.gov), Venkat Srinivasan (LBNL),

Vincent Battaglia (LBNL) [vsbattaglia@lbl.gov](mailto:vsbattaglia@lbl.gov)

## X-Ray Imaging Technologies for Energy Storage

Technique	Measures what	Contact	Problem
u-XT Micro X-ray Tomography 8-60KeV	3D visualization >2um	Alastair MacDowell Beamline 8.3.2	
SAXS, Small angle X-ray scattering. hv=10KeV	Sizes <50nm Sample size ~ mm Averaging technique	Alex Hexamer Beamline 7.3.3	
u-XRD, micro X-ray Diffraction 10-23KeV	2D mapping of crystal grain structure. Grain orientation, strain, Resolution ~ 0.5um	Nobomichi Tamura Beamline 12.3.2	
u-XAS Micro X-ray Absorption spectroscopy 3-14KeV	2D elemental mapping with chemistry, Spatial resolution ~ 1um	Mathew Marcus Beamline 10.3.2	
STXM, Scanning Transmission X-ray Microscopy 200-650eV	2D transmission map with elemental specificity and chemistry Resolution ~30nm Sample thickness ~ 1-10 um	David Kilcoyne 5.3.2 Tolek Tyliczszak 11.0.1	
FTIR, Fourier Transform Infra Red Spectroscopy.	2D mapping of vibration modes – chemistry, resolution ~ 2um	Mike Martin Beamline 1.4	
Surface			
PEEM, Photoemission Electron Microscopy 200-1000eV	2D imaging of surfaces to depth ~5nm. Elemental specificity, chemistry, resolution ~30nm	Andreas Scholl Beamline 11.0.1	
Surface Science 60-1200eV	Surface and material science, Spectromicroscopy	Jinghua.Guo 7.0.1 John Denlinger 8.0.1	
Theory	X-ray absorption simulation	David Prendergast Theory Group Molecular Foundry	