## Novel Trends in Synchrotron and FEL-Based Analysis Focus Topic

## Room Hall D - Session SA-TuP

## Novel Trends in Synchrotron and FEL-Based Analysis Poster Session

**SA-TuP1 Transmission X-Ray Microscopy Characterization of PtNi Extended Surface Catalysts within MEAs for PEMFCs**, ***Sarah Shulda***, Colorado School of Mines; *J. Nelson Weker,* SLAC National Accelerator Laboratory; *C. Ngo,* Colorado School of Mines; *S. Mauger, K.C. Neyerlin, S. Alia, B. Pivovar,* National Renewable Energy Laboratory; *S. Pylypenko,* Colorado School of Mines

Proton exchange membrane fuel cells (PEMFCs) have a high power-to-weight ratio making them well suited for transportation applications. Platinum (Pt) nanoparticles on high surface area carbon is the current state of the art catalyst for the oxygen reduction reaction at the cathode. However, the high cost and inherent durability issues of this catalyst significantly limit the commercialization potential of PEMFCs in automobiles. Pt nanowires are a promising alternative to the carbon-supported Pt nanoparticles. High surface area platinum nickel (PtNi) nanowires have been synthesized and demonstrated exceptionally high activity and durability in electrochemical studies using rotating disk electrodes (RDEs). The incorporation of nanowire catalysts into full membrane electrode assemblies (MEAs) is not straightforward due to significant differences in the morphology of these materials as compared to traditional catalysts based on carbon-supported nanoparticles, and requires optimization of electrode composition and structure. Factors effecting the performance of the electrodes include catalyst content, amount of ionomer, amount and type of carbon additive, the three dimensional morphology of the nanowires, and nanowire contact with each other and with the other constituents of the MEA. In the specific case of NiPt nanowires, preventing Ni leaching is also imperative as Ni will poison the fuel cell and inevitably cause a significant drop in performance. Optimization of these parameters requires detailed understanding of the electrode structure, preferably using non-destructive techniques.

Transmission x-ray microscopy (TXM) allows for non-destructive three-dimensional analysis of full MEAs providing detailed information on electrode composition and structure. Ni and Pt are imaged separately through selective tuning of the incident x-ray energy, making their relative distribution throughout the MEA readily discernible. A series of MEAs with varying ink compositions was analyzed with TXM to study the effects of ionomer content, amount and type of carbon, and addition of poly(acrylic acid) (PAA) on electrode structure. MEAs pre-leached with acid to remove Ni were also imaged. Results demonstrated that ink formulations and acid leaching significantly impacted the nanowire morphology within the MEA. The addition of graphitized carbon nanofibers (GCNFs) resulted in more homogeneous and less densely packed nanowire distribution. Scanning electron microscopy (SEM), transmission electron microscopy (TEM), and scanning transmission electron microscopy (STEM) with energy dispersive elemental mapping complemented the TXM studies.

**SA-TuP2 *In Operando* X-ray Imaging and Scattering from Detonating High Explosives**, *M. Bagge-Hansen, M. Nielsen, L. Lauderbach, R. Hodgin, S. Bastea, L. Fried, D. Hansen, C. May, T. van Buuren,* ***Trevor Willey***, Lawrence Livermore National Laboratory

The detonation of CHNO high explosives can generate an array of carbon nanomaterials including nano-onions, nano-diamond, and graphene products. The formation of these solid carbon phases occurs rapidly over the first several hundred nanoseconds, and a means to experimentally interrogate carbon nanomaterial formation during detonation will improve computational modeling and predictions of detonation phenomena. Experimental probes of carbon condensation under the extreme pressure and temperature conditions present during detonation at 100 ns timescales have been technically challenging to-date. Here, we present a new time-resolved small-angle x-ray scattering (SAXS) end-station, developed at LLNL and deployed at the Advanced Photon Source. This end-station at the Dynamic Compression Sector is capable of synchronously initiating detonation, and acquiring either small-angle x-ray scattering, or x-ray transmission radiographic images from discrete 80 ps x-ray pulses, which arrive every 153.4 ns during 24-bunch mode. The endstation can be trivially switched between SAXS and imaging modes. Images reveal densification within the explosive reaction zone, as well as detonation front curvature, and detonation velocity. The SAXS patterns demonstrate dramatic variation in the morphology and size of particles produced by different explosives. This work was performed under the auspices of the US DOE by LLNL under Contract DE-AC52-07NA27344

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