USAXS FACILITY AT ADVANCED PHOTON SOURCE FOR ANALYSIS OF MODERN MATERIALS NANOSTRUCTURES

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Modern materials – polymers, ceramics, metals, and their composites exhibit complex hierarchical microstructures spanning over many decades in sizes – generally from nanometers to over microns. Achieving an understanding of these complex microstructures requires characterization methods that provide statistically representative information over this large dimension range. Ultra small-angle X-ray scattering (USAXS) is an invaluable tool to address this need.

The Advanced Photon Source (APS) USAXS facility (http://usaxs.xor.aps.anl.gov) currently installed at 32ID beamline, uses a Bonse-Hart design . It has been developed into a robust and reliable instrument, providing an intensity dynamic range of up to 9 decades, and a scattering vector ($\boldsymbol{q}$) range of 4 decades (0.0001 to 1 A^{-1}). This instrument is uniquely suited to many problems in materials science, chemistry, medicine, and biology, with its ability to characterize, in a single measurement, scattering features ranging in size from nanometers to micrometers. Among many advantages of this instrument are high $\boldsymbol{q}$-resolution of 0.0001 A^{-1} which is independent of the absolute $\boldsymbol{q}$ value, standard-less absolute intensity calibration, and USAXS imaging capabilities. Flexible beam sizes from 0.01 mm^2 (20 μm high x 0.5 mm wide) to 1.5 mm^2 (0.5 mm high x 3 mm wide) allow characterization of both small samples (or gradient microstructures) and statistically representative volumes of up to few mm^3.

Both slit-smeared (1D-collimated) and 2D-collimated effective pinhole configurations are routinely available. For slit-smeared data, a robust numerical desmearing code is included within the data evaluation software package provided.

The presentation will cover basic principle of this instrument design, software data reduction and analysis packages. Examples of scientific applications in the characterization of nanomaterials, for which this facility is uniquely suitable, will be presented.

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