

Neutron-based multi-scale, multi-modal imaging of geological systems

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Neutrons provide a unique, complimentary view of the world. They readily and non-destructively penetrate several centimeters of common metals yielding detailed 3D image data sets. Three emerging methods provide additional image contrasts that provide better structural characterization for complex systems such as geological specimens.

At NIST, we have developed NeXT, a truly simultaneous neutron and x-ray tomography system that captures the 3D structure of a sample at the same time – a critical aspect for slowly evolving structures in porous media. The two modes allow for better volume segmentation, for instance in allowing to clearly identify organic matter from voids in shales and meteors.

Wavelength selective imaging, the collection of tomograms at different neutron wavelengths, enable one to nondestructively identify large crystal domains in samples. This is possible by analyzing the appearance of Bragg-edges, where the transmission sharply increases when the wavelength is larger than twice the lattice spacing for a given crystal plane. Cataloging where these edges occur allows one to estimate the composition of a bulk sample.

Far field interferometry extends the length scale range in neutron imaging to the nanometer. By measuring the loss of visibility as the autocorrelation length of the interferometer is varied, one maps out the pair-correlation function of the sample over a volume of about $(100\text{ }\mu\text{m})^3$. Effectively, one is measuring small angle scattering patterns in voxels, allowing one to map out how the porosity changes (pore size, volume fraction, etc.) throughout the sample.

The talk will provide an overview of each method with its application to a geological specimen of interest.