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Collaborative Research: Structure-Property Relationships of Novel Rare Earth-Ultraphosphate Glasses

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Program Goal: Develop a comprehensive understanding of the relationships between the composition, structure, and properties (magnetic and optical) of novel rare earth-phosphate glasses.

Photo: UND graduate student Mustafa Rajabali and Joan Siewenie (Scientific Associate, Argonne NL) inspecting the sample changer of GLAD neutron diffractometer at the Intense Pulsed Neutron Source, Argonne National Laboratory.

Atomic structure and magnetic properties of novel rare earth phosphate glasses are being probed using techniques such as high energy X-ray diffraction (HEXRD), neutron diffraction (ND), X-ray absorption spectroscopy (XAS), IR/Raman spectroscopy, and AC magnetic susceptometry. Students and faculty travel to Argonne National Laboratory for HEXRD and ND experiments and to Stanford Synchrotron Radiation Laboratory for XAS experiments.

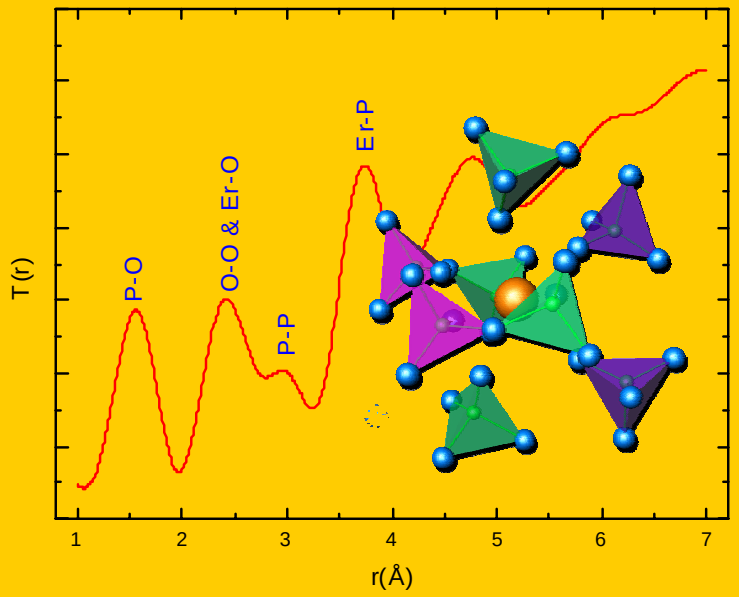

Figure: The pair distribution function at right, calculated from HEXRD data, is for an erbium ultraphosphate (O/P<0.3) glass. Pair assignments shown are preliminary. The structural model (inset) shows the 5 Å coordination environment around an erbium atom.At these compositions, rare earth atoms are surrounded by approximately eight PO_4 tetrahedra. There are no rare earth-rare earth correlations at these distances.

Outreach: Science in the Circle of Life

Our laboratory is the Physics Site for North Dakota's "Science in the Circle of Life (SiCoL)" program. SiCoL is a Howard Hughes Medical Foundation-funded program administered by the Dakota Science Center of Grand Forks. The goal of SiCoL is to bring middle schoolers primarily from the State's Native American Reservations to University of North Dakota (UND) to work side-by-side with selected UND researchers.

For approximately two weeks in June, a group of six 7th and 8th graders work with our research group conducting research related to the atomic structure of materials. The students prepare samples, study them using X-ray diffraction, and learn to build virtual crystal structures.

Students, their tribal elders, community leaders, and faculty mentors meet frequently during this period to discuss, among other things, how what students are learning relates to Native American teachings, beliefs, and ways of life.

Photo: Grinding samples for X-ray analysis, Elizabeth, a 7th grader from Fort Berthold Indian Reservation, discovers a messy side of physics.

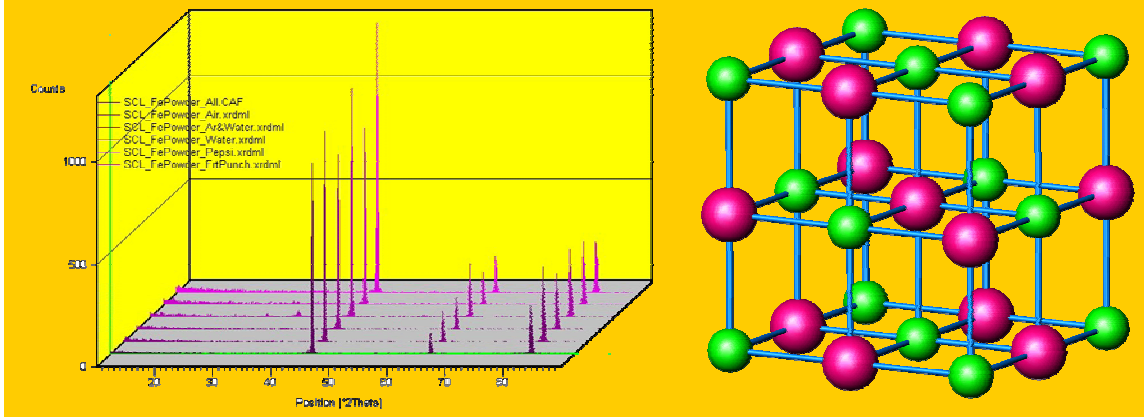

Figure: A comparison of X-ray patterns measured by SiCoL students for iron powder samples exposed to different atmospheres (left) and a virtual NaCl crystal structure built by Latitia and Alex (see photo at right) using Atoms software package.

Photo: 7th graders Latitia (left, Fort Berthold Indian Reservation) and Alex (Standing Rock Indian Reservation) concentrating on building virtual crystal structures.