Spring 2017

Geol 7900 Special Topics

Synchrotron-X-Ray Based Analytical Techniques

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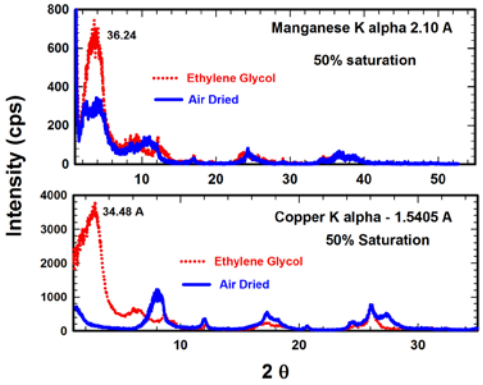
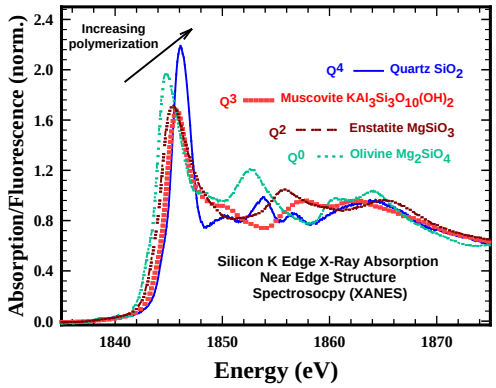
Prerequisite: Sophomore level chemistry and physics, or consent of instructor.

The properties of materials, for example, geological and environmental materials, from rocks to soils, need to be known in detail to understand and predict their behavior. These properties may include phases present and their chemical composition, bulk chemical composition in terms of major or trace elements, an element's speciation, particle size or three dimensional relationship among various constituents. A toxic element may be adsorbed onto a mineral's surface instead of being within its crystal structure.



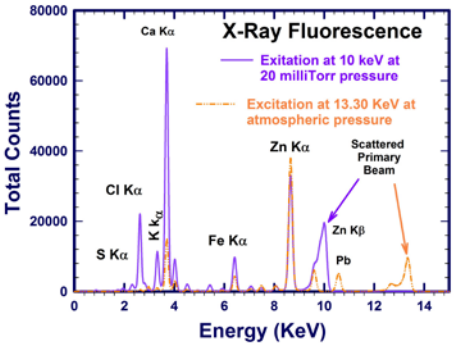
Smectite clay run at two wavelengths



X-ray based methods can provide this type of information. X-ray diffractometry is widely used across many scientific disciplines for studying the properties of crystalline phases. While many materials are crystalline others can be amorphous and cannot be studied by X-ray diffractometry. X-ray absorption spectroscopy, which probes only the local atomic order, is an excellent tool for studying amorphous materials such as glasses. X-ray absorption spectroscopy is also a great tool for investigation of the fate of heavy metals in soils. X-rays also allow imaging objects in three dimension at the micrometer resolution and thus the porosity of rocks in petroleum reservoirs can be studied in a non-invasive manner. The dimensions of minerals from the nanometer to the hundreds of nanometers scale can be quantified by X-ray diffractometry and small angle X-ray scattering.

The X-ray source for all these analytical techniques can be a sealed tube but synchrotron radiation from an electron storage ring provides several orders of magnitude higher brightness and a very broad spectral range. The following techniques will be covered in the course:

- X-ray absorption spectroscopy
- X-ray fluorescence spectrometry
- X-ray diffractometry
- Small angle X-ray scattering
- X-ray computed tomography



Municipal waste incineration residue

The course will cover the basic principles of these techniques with more emphasis on the physical aspects and less on the mathematics. These X-ray based techniques are equally applicable in Geological, Environmental and Soil Sciences, Chemistry, and Chemical Engineering.

This is primarily a laboratory-based course. The student is expected to write a term paper based on at least two techniques. The final grade will be based on the term paper and a comprehensive final examination.

The class will meet Wednesdays from 1:30 pm to 4:30 pm at the J. Bennett Johnston, Sr., Center for Advanced Microstructures and Devices (CAMD), Louisiana State University, 6980 Jefferson Highway, Baton Rouge.