Materials Characterization

SIOG 239

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Office hours by appointment
Lecture: 1.5 hours twice a week

Course description:
This is a survey course in materials characterization geared towards SIO researchers in the earth, environmental, planetary, oceanographic and biological sciences. It will include a hands-on project using SEM facilities at SIO/UCSD. Emphasis will be placed on surface analysis techniques. The course will introduce the fundamental theoretical framework for spectroscopy, diffraction, and imaging methods used in structural and compositional characterization of materials. Analytical techniques including, but not limited to: electron microbeam (SEM, TEM), spectroscopic methods (IR, Raman), and mass spectrometry (laser ablation ICP-MS, SIMS) will be discussed. At the end of the quarter, students should be able to make educated decisions regarding the selection of appropriate characterization methods for a particular research problem.

Course objectives/outcomes for success:

1. Discuss the relative advantages and disadvantages for the techniques covered in class
2. Be able to identify and justify the selection of at least 3 techniques to evaluate a particular sample
3. Be given an unknown sample (or have one from own research) and collect a targeted dataset on it using an instrument available on campus

Course materials:
Textbooks (will be on reserve):
Encyclopedia of materials characterization: surfaces, interfaces, thin films. Brundle, Evans, and Wilson (1992). Butterworth-Heinemann

Scanning electron microscopy and x-ray microanalysis. Third Edition. Goldstein, Newbury, Joy, Lyman, Echlin, Lifshin, Sawyer, Michael. (2003). Kluwer Academic/Plenum Publishers

Electron microprobe analysis and scanning electron microscopy in geology. Reed., S. J. B. (2006). Cambridge Univ. Press

Handbook of silicate rock analysis. Potts, P. J. (1992) Springer

Course materials will also include in-class Powerpoint presentations and selected peer-reviewed, scientific literature

Grading:
Class participation: 20%
2 review presentations*: 30%
Hands-on lab project, write-up and in-class presentation**: 30%
Final exam: 20%

*Review presentations will focus on recent journal articles that highlight one technique covered in previous classes. Presentations should focus on application of the technique. Presentations should be maximum ~15 minutes with 5 minute class discussion.

**At the start of the quarter, students will select a sample from a class set or one that is relevant to their own research. They will identify a specific dataset they want to obtain from the sample (e.g., an X-ray elemental map, identification of unknown phases, a high-resolution image of a surface, etc.). Students will outline in 1 page what data they aim to acquire and how they will acquire it using accessible on-campus facilities (SEM and associated detectors); prior to collecting data they must get instructor approval for the project. A time outside of class will be scheduled to prep sample (if needed), obtain required training, and conduct the analyses (estimated 4-8 hours). Students will summarize results in a short write-up (~5 pages) and in-class presentation (15 minutes) outlining the problem, sample description, methods, results, and analysis.

Tentative course schedule:

WEEK 1. Introduction.
Microscopy: different microscopy techniques
Resolution, magnification, depth of field
Imaging – theory and concepts

WEEK 2. X-ray microanalysis: EDS, WDS, EPMA (Surface analysis)

WEEK 3. XRD, EBSD, TEM (Applications to crystallography)

WEEK 4. X-ray methods (EDS, WDS, XRF, XANES, XPS, EXAFS)
1-page proposal for term project due

WEEK 5. Review paper presentations

WEEK 6. X-ray methods continued

WEEK 7. Scanning force microscopy (AFM)
Spectroscopy (IR, Raman)

WEEK 8. Review paper presentations

WEEK 9. Mass spectrometry techniques (LA ICPMS, SIMS)
WEEK 10. Project presentations