X-ray Diffraction Laboratory

Introduction to Experimental X-ray Diffraction Techniques

Course Number: MATSCI 162/172

Quarter: Winter, 2010

Instructor:
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Class meets:
Lecture – Wednesday, 3:15 – 5:05 pm.
Hewlett Teaching Center 102.
Laboratory – Thursday: Groups 1 and 2, Friday: Groups 3 and 4.
GLAM X-ray Lab.

The lectures will cover background material. Additional time (scheduled in consultation with the instructor) will be required for demonstrations of the equipment and completion of the Lab work.

References:

Highly Recommended:

1. Lecture Notes.
   Class Homepage:
   http://www.stanford.edu/group/glam/xlab/MatSci162_172/MatSci.htm
2. B.D. Cullity, S.R. Stock, "Elements of X-Ray Diffraction", 2001.

Recommended:

1. C. Hammond, "The Basics of Crystallography and Diffraction", 2001.
2. B.E. Warren, "X-Ray Diffraction", 1990.
3. J. Als-Nielsen, D. McMorrow, "Elements of Modern X-ray Physics", 2001
4. D. K. Bowen, B. K. Tanner, "High Resolution X-Ray Diffractometry and Topography", 1998.
5. P.F. Fewster, "X-ray Scattering from Semiconductors", 2000.
6. C. Suryanarayana, M. Grant Norton, "X-Ray Diffraction a Practical Approach", 1998.

Prerequisites: Students must complete all relevant safety training before working in the X-ray Lab.

Who Should Take this Class: The class is intended to be an introduction to x-ray diffraction and experimental techniques. Undergraduates/Graduates.

Educational Objectives

1. Learn the principles of x-ray safety and how to handle x-ray equipment.
2. Develop an understanding of the properties of x-rays.
3. Learn a Bragg's Law interpretation of x-ray diffraction and the concept of the reciprocal lattice.
4. Learn the use of the Laue and powder method to study materials.
5. Use modern x-ray diffractometer as a tool to study materials in a quantitative sense.
6. Develop an understanding of the principles of structural analysis of powders, single crystals and thin films using the x-ray diffractometer.
7. Develop an understanding through a combination of lecture and laboratory exercises, the principle methods of materials analysis by X-ray diffraction, and to be able to apply them to specific materials analysis problems.
8. Improve and have strategies for further improving your technical writing.

Grading

1. 90% – four written assignments. Although students will perform the experiments in groups, each student must independently prepare and submit a report.
2. 10% – weekly quizzes. The quizzes are designed to review main points of the previous lecture. The quizzes will be done in class.

Course Element	Contribution to Final Grade
Written Assignments:	90%
a) Style	(33.3%)
b) Experimental Work & Analysis	(66.7%)
Quizzes	10%
Total:	100%

Laboratory Reports

Reports will be graded on style (1/3) as well on the quality of experimental work and the analysis (2/3). Details of the Labs and report requirements will be available starting at the 3rd class meeting.

Late reports. Everyone will have 3 days of extension at the beginning of the quarter (e.g. 3 one-day extensions or 1 three-day extension). Write on the cover of the report that you are using "x" extension days. After this late reports will lose one letter grade per day.

Schedule for Winter 2010

Date	Lecture (Wednesdays)		Laboratory (Thursdays, Fridays)	
1/6	1.	Properties of X-rays. X-ray Safety.		
1/13				Safety Questionnaires Due
1/13	2.	Geometry of Crystals. Introduction to Reciprocal Lattice.		
1/14 1/15				Introduction to X-ray Lab: X'Pert Materials Research Diffractometer, Laue Diffractometer G1: 10 – 12pm; G2: 2 – 4pm; G3: 10 – 12pm; G4: 2 – 4pm
1/20	3.	Kinematical Theory of X-ray Diffraction. Laue Method. Powder Method.		
1/21 1/22			1	Powder Diffraction. Determination of Crystal Structure. Powder Diffraction File. G1: 10 – 12pm; G2: 2 – 4pm; G3: 10 – 12pm; G4: 2 – 4pm
1/27	4.	Real Samples.		
1/28 1/29			1	Continued G1: 10 – 12pm; G2: 2 – 4pm; G3: 10 – 12pm; G4: 2 – 4pm
2/3	5.	Thin Film Structural Analysis: Stress & Texture.		
2/4 2/5			2	Texture Measurement. **Lab 1 Due.** G1: 10 – 12pm; G2: 2 – 4pm; G3: 10 – 12pm; G4: 2 – 4pm
2/10	6.	Diffractometer Geometry. Optics. Detectors.		
2/11 2/12			2	Continued G1: 10 – 12pm; G2: 2 – 4pm; G3: 10 – 12pm; G4: 2 – 4pm
2/17	7.	Heteroepitaxial Layers: Rocking Curve, Mismatch, Reciprocal Space Mapping		
2/18 2/19			3	High Resolution XRD: Layer Thickness, Composition, and Mismatch. **Lab 2 Due.** G1: 10 – 12pm; G2: 2 – 4pm; G3: 10 – 12pm; G4: 2 – 4pm
2/24	8.	Diffraction from Multilayers and Superlattices		
2/25 2/26			3	Continued G1: 10 – 12pm; G2: 2 – 4pm; G3: 10 – 12pm; G4: 2 – 4pm
3/3	9.	Reflectivity. Diffraction from Amorphous Materials.		
3/4 3/5				X-ray Reflectivity. **Lab 3 Due.** G1: 10 – 12pm; G2: 2 – 4pm; G3: 10 – 12pm; G4: 2 – 4pm
3/10	10.	Grazing Incidence Diffraction. Examples.		
3/12				**Lab 4 Due. All Corrected Reports are Due.**