Introduction to Experimental X-ray Diffraction Techniques

Description of the course: This course covers experimental x-ray diffraction techniques used for analyzing the microstructure of materials. Topics include powder diffraction, as well as diffraction techniques for polycrystalline and epitaxial thin films, multilayers, and amorphous materials, using both medium and high-resolution setups. Students will learn methods for assessing phase purity, crystallinity, relaxation, stress, and texture in materials. The course also introduces advanced techniques, such as reciprocal lattice mapping, x-ray reflectivity, and grazing incidence diffraction.

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References:

1. Lecture Notes.
2. B.D. Cullity, S.R. Stock, "Elements of X-Ray Diffraction", 2001.
3. C. Hammond, "The Basics of Crystallography and Diffraction", 2001.
4. B.E. Warren, "X-Ray Diffraction", 1990.
5. J. Als-Nielsen, D. McMorrow, "Elements of Modern X-ray Physics", 2001
6. P.F. Fewster, "X-ray Scattering from Semiconductors", 2000.

Prerequisites for the class: Introductory **Physics:** A foundational understanding of physics, particularly in areas of waves, optics, and electromagnetism, to grasp the principles of x-ray interaction with matter.

Materials Science Basics: Knowledge of basic materials science concepts, such as crystallography, material phases, and microstructures, would be essential, as these are core topics in diffraction analysis.

Mathematics: Competency in algebra, trigonometry, and basic calculus, as these are often needed to understand diffraction equations, lattice spacing calculations, and data interpretation.

Introductory Chemistry (optional, but beneficial): Understanding atomic and molecular structure can help students interpret diffraction results, especially when working with material composition and phase analysis.

Educational Objectives: Understanding **Core Principles:** Students will grasp the foundational concepts of x-ray diffraction and its application to microstructural analysis of different material types, including polycrystalline, epitaxial thin films, and amorphous materials.

Practical Application of Techniques: Students will learn to use various x-ray diffraction techniques (e.g., powder diffraction, medium and high-resolution configurations) for determining phase purity, crystallinity, relaxation, stress, and texture.

Proficiency in Advanced Techniques: Students will develop basic skills in advanced diffraction methods, including reciprocal lattice mapping, x-ray reflectivity, and grazing incidence diffraction.

Data Analysis and Interpretation: Students will gain experience analyzing and interpreting x-ray diffraction data to evaluate microstructural properties and will learn how these properties impact material performance.

Schedule for November 2024:

18-20 November, 232 a. (Studentų str. 50, Department of Physics, MGMF).
21 November, 238 a. (Studentų str. 50, Department of Physics, MGMF).

Date		Lectures
11/18 9:00 – 13:00	1.	Properties of X-rays. Geometry of Crystals. Introduction to Reciprocal Lattice. Diffractometer Geometry. X-ray Optics. Detectors. Kinematical Theory of X-ray Diffraction.
11/19 9:00 – 13:00	2.	Powder Method. Powder Diffraction File. Diffraction from Real Samples. Thin Film Structural Analysis. Stress & Texture Measurements.
11/20 9:00 – 13:00	3.	Stress & Texture Measurements. X-ray Reflectivity. Epitaxial Layers. Rocking Curve, Mismatch, Reciprocal Space Mapping.
11/21 9:00 – 11:00	4.	Practical examples. Discussions.