

**Department of Materials Science and Engineering  
University of Maryland**

**ENMA 489M: Diffraction Techniques in Materials Science (Elective)**

**Course Description:** Introduction to diffraction from materials due to their structure or lack thereof.

**Pre-requisite:** Professor's permission

**Textbook:**

Required: The Structure of Materials, S. M. Allen and E. L. Thomas, Wiley, 1999, in the library; X-ray Diffraction, E. B. Warren, Dover, re-release of the Addison-Wesley version of 1969, in the library. Recommended: Diffraction Physics, J. M. Cowley, in the library

**Course Objectives:** At the end of this course, the student should be able to relate the three groups of materials, non-crystalline, crystalline and liquid crystalline with the diffraction they generate; identify the different diffraction techniques used to look at the three materials groups; understand how the combination of translation, rotation and mirror reflections give rise to the different symmetry groups; understand how defects in materials reflect in the diffraction properties; and understand how the different groups of materials give rise to different diffraction signals.

**Topics Covered:**

- I. Introduction (or review) of terms:
    - a. Symmetry, bonding
    - b. Coordination number
    - c. Packing fraction
    - d. Order and disorder
  2. Relations:
    - a. Bragg's law
    - b. Lattices
    - c. Reciprocal space
    - d. Atomic Scattering
- II. Crystalline State
1. Two-dimensions
    - a. Lattices
    - b. Rotational and reflection symmetry
    - c. Derivation of the two-dimensional point groups
  2. How to study two-dimensional structures using diffraction – what signal do we obtain
  3. Three dimensions
    - a. Symmetry operations unique to three dimensions
    - b. Techniques for three dimensional special relationships
    - c. The thirty-two crystallographic point groups and 230 space groups
    - d. Symmetry constraints on material properties
  4. How to use the space groups to determine diffraction

### III. Non-crystalline Solids

1. Generic descriptors
2. Models:
  - i. Hard-sphere
  - ii. Random walk
  - iii. Network models
3. How to study non-crystalline models using diffraction – what signal do we obtain

### IV. Liquid Crystalline State

1. Phases of liquid crystals
2. Materials that exhibit liquid crystalline structure
3. Descriptors for liquid crystals
4. How to study liquid crystalline materials using diffraction – what signal do we obtain
5. Applications of liquid crystals

### V. Imperfections in Ordered Media

1. Point imperfections
2. Line imperfections
3. How are imperfections reflected in the diffraction signal

#### **Course schedule:**

Lecture: Mon - Wed 3:30 - 4:45PM, RM. JMP 1202

#### **Course Goals to meet ABET 2005 Criteria:**

1. Relate the three groups of materials, non-crystalline, crystalline and liquid crystalline with the diffraction they generate.
2. Identify the different diffraction techniques used to look at the three materials groups
3. Understand how the combination of translations, rotations and mirror reflections give rise to the different symmetry groups.
4. Understand how defects in materials reflect in the diffraction properties
5. Understand how the different groups of materials give rise to different diffraction signals.

#### **Contribution of course to meeting the professional component:**

This course is an elective for both undergraduates as well as graduate students.

#### **Contribution of course to program objectives:**

This is a specialization elective for undergraduates.

**Prepared by:** Prof. L. Martínez-Miranda, January 2005