

MATRL 218/CHEM 277: Introduction to Inorganic Materials

Catalog Description:

This course introduces to typical inorganic materials, with an emphasis on crystalline materials (some discussion of quasicrystalline and amorphous materials) and how their intrinsic material properties (as opposed to properties dictated by defects *etc.*) can be understood based on the constituent atoms, and the crystal and electronic structures. Includes rudiments of crystallography, and notions of how crystal structures can be considered from the concepts of close-packing, and of the linking of polyhedra. Some discussion of specific structure types with reference to advanced material properties such as metallic vs. insulating behavior, magnetism, ferroic properties, and superconductivity.

Target audience:

The course is for graduate students with some prior knowledge of inorganic materials and crystallography. Advanced undergraduate students are welcome. Materials 100A would be a typical pre-requisite.

Textbooks (none are required):

The Basics of Crystallography and Diffraction, C. Hammond, Oxford-IUCr, 1997. ISBN 0-19-855945-3

Electronic Structure and Chemistry of Solids, P. A. Cox, Oxford University Press, 1987. ISBN 0-19-855204-1

Inorganic Structural Chemistry, U. Müller, John Wiley, 1993. ISBN 0-471-93717-7

Crystal structures: A Working Approach, H. D. Megaw, W. B. Saunders, 1973. ISBN 0-721-66260-9

Structure of Materials, M De Graef and M. E. McHenry, Cambridge University Press, 2 edition, 2012.

Course Website:

<http://www.mrl.ucsb.edu/~seshadri/teach.html>

Grading:

5 best from 6 or 7 assignments (20%), midterm (35%), Take-home final (45%).

Outline:

1. Recent excitement in understanding structure-property relationships
2. Classification of materials as amorphous and crystalline, and the structural hierarchy in a polycrystalline material. Quasicrystalline and amorphous materials. The glass transition.
3. Cohesion in solids ionic, covalent, metallic, van der Waals
4. Crystallography in a nutshell: Lattices, unit cells, symmetry: how crystallography simplifies the depiction of structures
5. Packings: CCP and HCP, voids, radius ratio rules, the structures of elements – α -Po, Fe, Cu, Mg, Si, C (graphite)
6. Pauling's rules for ionic crystals and the concept of Bond Valence
7. Description of some crystal structures: AB, AB₂, AB₃ (ReO₃), perovskites, K₂NiF₄
8. Electronic structures of crystalline solids – energy bands, densities of states, crystal fields, the band gaps in semiconductors
9. Metals, non-metals and the metal-insulator transitions, examples of perovskites
10. Cooperative magnetism in solids – examples of perovskites and spinels
11. Structural phase transitions in solids – the example of BaTiO₃
12. Special topics: Structure-property relations in advanced materials:
 - (a) GMR/CMR: Systems and phenomena
 - (b) Polar materials: Normal and relaxor ferroelectrics, and piezoelectric materials
 - (c) High T_C superconductors