MATRL 218: Introduction to Inorganic Materials

Catalog Description:

An introduction to typical inorganic materials, both crystalline and amorphous, and how their material properties can be understood based on the constituent atoms, and the crystal and electronic structure. Also includes rudiments of crystallography and crystal defects, and building up structures using 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 superconductivity, ferroic behavior and magnetism.

Teaching frequency:

Every year in Winter.

Target audience:

The course is for graduate students with little prior knowledge of inorganic materials, but is also suitable for students who have had prior exposure to the subject.

Textbooks:

Solid State Chemistry: An Introduction, L. Smart and E. Moore, Second Edition.

Electronic Structure and Chemistry of Solids, P. A. Cox.

Other references:

The international tables of X-ray crystallography, Vol. I

Inorganic crystal structures, B. Hyde and S. Andersson

Current literature

Instructor:

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Course Website:

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

Outline:

1. Inorganic materials in everyday life

   Microwave-proof casseroles, cell-phone batteries, jet turbines, space shuttle tiles, DNA labels

2. Classification of materials as amorphous and crystalline, and the structural hierarchy in a polycrystalline material

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, α-Fe, Cu, Mg, Si, C (graphite)

6. Pauling's rules for ionic crystals and the concept of Bond Valence

7. Description of crystal structures: AB, AB_2, AB_3 (ReO_3), perovskites, K_2NiF_4

8. Defects in solids — Point, line, planar, crystallographic shear

9. Electronic structures of crystalline solids — energy bands, densities of states, crystal fields, the band gaps in semiconductors

10. Metals, non-metals and the metal-insulator transitions — examples of perovskites

11. Cooperative magnetism in solids — examples of perovskites and spinels

12. Structural phase transitions in solids — the example of $BaTiO_3$

13. Special topics: Structure-property relations in advanced materials:

    GMR/CMR: Systems and phenomena

    Polar materials: Normal and relaxor ferroelectrics, and piezoelectric materials

    High T_C superconductors