

MATRL 100A: Structure and Properties I

Catalog Description:

The course provides an introduction to materials in modern technology. The internal structure of materials meaning the spatial organization of atoms, diffraction techniques to determine these, and the nature of bonding, are discussed and related to their electrical, magnetic, thermal, and optical properties.

Teaching frequency:

Every year

Target audience:

This is a junior level course sequence required of all students in the BS/MS program. It is also taken as an elective by senior undergraduates in science and engineering.

Prerequisites:

Chemistry 1A-B, Physics 4, and Mathematics 5A-B-C.

Textbook (required):

W. D. Callister and D. G. Rethwisch, *Materials Science and Engineering: An Introduction*, 8th Edition, Wiley, January 2010. Please note that problems sets will make use of the text.

Instructor:

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Course Website:

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

Grading:

35% for an in-class (1 h) midterm, 50% for an in-class (3 h) final, and 15% for assignments.

Outline:

Introduction to materials in modern technology: Materials as an enabling element of technological progress. Functions that materials perform. The properties – structure – processing connection.

The structure of materials: Atomic structure. Bonding in molecules and solids. Molecular and extended solids. The arrangement of atoms in liquids, crystals, quasicrystals and amorphous materials. Crystal structures, directions and planes.

Imperfections in solids: Point, line and interfacial defects. Vacancies, self-interstitials, impurities/solute atoms. Entropy effects. Dislocations, grain boundaries and interfaces. Microstructure.

The structure of ceramics Crystal structures, carbons.

Polymer structures: Hydrocarbon and polymer molecules, the chemistry of polymers, molecular weight, molecular shape, structure, and configurations/

Electrical properties of materials: Electrical conduction, energy band structures and relationship to bonding. Semiconductors, intrinsic/extrinsic semiconduction and temperature effects. Hall effect. Semiconductor devices. Conduction in ceramics and polymers. Dielectric behavior and capacitance. Ferroelectrics and piezoelectrics.

Thermal properties of materials: Heat capacity, thermal expansion, thermal conductivity.

Magnetic properties: Basic concepts of magnetism. Types of magnetic behavior, Magnetic domains, soft and hard magnets, magnetic devices and superconductivity.

Optical properties: Basic concepts. Refraction and reflection. Absorption and transmission, color. Luminescence, photoconductivity and photovoltaic devices. Lasers and light-emitting diodes.