

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, and the nature of bonding are discussed and related to their electrical, magnetic 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):

Fundamentals of Materials Science and Engineering, by William D. Callister, Seventh Edition, John Wiley & Sons 2007.

Instructor:

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Course Website:

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

Grading:

30% for an in-class (1 h) midterm, 40% for an in-class (3 h) final, and 30% for assignments.

Outline:

Introduction to materials in modern technology, Chap 1: Materials as an enabling element of technological progress. Functions that materials perform. The properties – structure – processing connection.

The structure and bonding of materials and diffraction, Chap 2 & 3: 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.

The structure of ceramics, Chap 12 (part): Some not-simple crystal structures.

Imperfections in solids, Chap 4: Point, line and interfacial defects. Vacancies, self-interstitials, impurities/solute atoms. Entropy effects. Dislocations, grain boundaries and interfaces. Microstructure.

Polymer structure, Chap 14: The chemistry of polymeric molecules.

Electrical properties of materials, Chap 18: 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, Chap 19W: Heat capacity, thermal conductivity and thermal expansion.

Magnetic properties, Chap 20W: Basic concepts of magnetism. Types of magnetic behavior, Magnetic domains, soft and hard magnets, magnetic devices and superconductivity.

Optical properties, Chap 21W: Basic concepts. Refraction and reflection. Absorption and transmission, color. Luminescence, photoconductivity and photovoltaic devices. Lasers and light-emitting diodes.