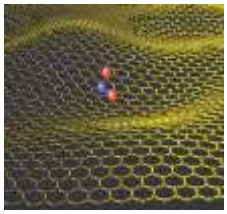

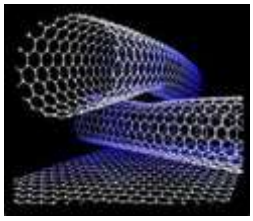

CBE_30361
SCIENCE OF ENGINEERING MATERIALS

CBE_30361: Science of Engineering Materials (3-0-3)
Required of all chemical engineering majors
Professor in Charge: Dr. Alexander S. Mukasyan
Pre-requisite: CHEM 1014
Co-requisite: CHEM 1016 or CHEM 10118 or CHEM 10121
Laboratory: None

Course Description: Materials have historically been so important that different eras of civilization were named according to the materials from which tools were fabricated; e.g. the Stone Age, the Bronze Age, and the Iron Age. The discovery of the semiconductor developed the modern era of information technology often called the Silicon Age. Advances in materials science might make this new millennium the Biomaterials/Nanomaterials/Optical Materials Age.

Science of Engineered Materials is a *broad, multidisciplinary field* devoted to understanding and manipulating the mechanical, electrical, optical and magnetic properties of materials. It is closely related to *chemical and mechanical, electrical and computing, bio- and civil engineering*. It studies fundamental characteristics of a variety of materials including metals, ceramics, polymers, and electronic materials.

This course considers: (a) how the physical properties of metals, ceramics polymers and composites are correlated with their internal structures (on atomic, molecular, crystalline, micro- and macro- scales) and operational conditions (mechanical, thermal, chemical, electrical and magnetic); (b) how materials processing, e.g. mechanical working and heat treatment, affects their properties, as well as environmental behavior. The latest achievements in Materials Science and Engineering are also discussed.

Course Goal is to develop an awareness of materials and their properties.

The following **objectives** for the course can be outlined:

- To introduce basic ideas, nomenclature, and testing of materials.
- To reveal relationships amongst *processing → structure → properties → performance*.
- To provide background in Materials Science (*structure - property relationships*)
- To provide introduction to Materials Engineering: designing sets of properties based on these relationships.
- To develop general concepts on materials selection and design.

Topics:

- Atomic scale: atomic bonding, bond Energy, bond Stiffness
- Crystal lattice scale: Metal, Ceramics, Semiconductor, Silicate, and Polymer Crystal Structures
- Nano and micro- scales: Defects in Solids; Grains and grain boundaries; Mechanisms of material's failure
- Mass transport: volume and surface diffusion, dissolution, reactive diffusion;
- Phase Diagrams
- Phase transformations
- Mechanical Deformation: Elastic Deformation in Metals, Ceramics, and Polymers; Plastic Deformation by Yielding and Creep; Viscoelastic Behavior; Fast and Fatigue Fracture; Critical Resolved Shear Stress
- Electronic Structure and Electrical Properties: Conductors, Superconductors, Semiconductors, Insulators, Ferroelectrics, Piezoelectric
- Magnetic Structure and Properties

Required Text:
WileyPLUS *for Materials Science and Engineering: An Introduction* ,W.D. Callister, Jr., David G. Rethwisch, 9-th edition, John Wiley and Sons, Inc., 2014.

Additional References:

- *Basic Concepts of Crystallography*, E. Zolotoyabko, Wiley-VCH, Weinheim, Germany, 2011.
- *Engineering Materials: Properties and Selections*, K. G. Budinski, M.K. Budinski, Pearson Education Inc., New Jersey, 2010.
- *Introduction to Materials Science for Engineers, J.F. Shackelford, 7th Edition, Pearson Education, Inc., New Jersey, 2010.*