Materials Science and Engineering

College of Engineering (http://coe.berkeley.edu)
Department Office: 210 Hearst Memorial Mining Building, (510) 642-3801

Chair: Mark D. Asta, PhD
Department Website: Materials Science and Engineering (http://mse.berkeley.edu)

Overview

The Department of Materials Science and Engineering (MSE) administers undergraduate and graduate programs in materials science and engineering. In addition, undergraduate students may be admitted to one of five joint major programs.

Materials Science and Engineering encompasses natural and man-made materials—their extraction, synthesis, processing, properties, characterization, and development for technological uses. Advanced engineering activities that depend upon optimized materials include the energy technologies, photovoltaics, batteries, and fuel cells, new medical devices and the healthcare industries, electronics and photonics, transportation, communication, and nanotechnology.

Students in materials science and engineering apply a basic foundation of mathematics, chemistry, physics, and engineering to fields of specialization that include biomaterials; electronic, magnetic, and optical materials; materials for energy technologies; structural materials; chemical and electrochemical materials science and engineering; and computational materials science and engineering. Nanoscale science and engineering plays an important role in all of these specializations.

See the *College of Engineering Announcement: A Guide to Undergraduate and Graduate Study* online (http://coe.berkeley.edu/students/college-of-engineering-announcement) for more information.

Biomaterials

Traditionally, biomaterials include synthetic alternatives to the native materials found in the human body. A central limitation in the performance of traditional materials used in the medical device, biotechnological, and pharmaceutical industries is their inability to integrate with biological systems through either a molecular or cellular pathway, which has relegated biomaterials to a passive role dictated by the constituents of a particular environment. The design and synthesis of materials that circumvent their passive behavior in complex mammalian cells is a major the focus of the work conducted within the Department of Materials Science and Engineering at UC Berkeley.

Chemical and Electrochemical Materials Science and Engineering

This area integrates the chemical and electrochemical processing of materials and the chemical and electrochemical behavior of materials. The former includes the scientific and engineering principles used in mineral processing, smelting, leaching and refining materials, along with numerous etching and deposition techniques. The latter includes the environmental degradation of materials, the compatibility of materials with specific environments, and the fundamental science and engineering development of materials used in advanced energy production and storage devices.

Computational Materials Science and Engineering

Computational methods are native to all facets of materials science and engineering. Such methods range from the theoretical prediction of the electronic and structural properties of materials to modeling fluid flow in advanced batteries, or modeling the chemical kinetics and equilibria in a materials processing operation.

Electronic, Magnetic, and Optical Materials

This group of materials is defined by its functionality. Semiconductors, metals, and ceramics are used today to form highly complex systems such as integrated electronic circuits, optoelectronic devices, and magnetic and optical mass storage media. In intimate contact, these materials with precisely controlled properties perform numerous functions, including the acquisition, processing, transmission, storage, and display of information. Materials research in this area combines the fundamental principles of solid state physics and chemistry with many branches of engineering.

Materials for Energy Technologies

Materials play a crucial enabling role in the energy technologies. All facets of energy harvesting, energy conversion, energy storage, energy delivery, and energy conservation are all included in this topic. Specific examples include photovoltaics, nuclear, solar, thermoelectrics, fuel cells, mechanical transducers, batteries, supercapacitors, low loss conductors, low density structural materials for weight savings, and integrated materials systems for automated control of energy utilization.

Nanomaterials

The science of materials at the nanoscale provides a rich scholarly focus at the confluence of basic science (physics, chemistry, biology, and mathematics) and the engineering disciplines. An interdisciplinary focus provides undergraduates with a comprehensive view of the key materials science issues in nanoscience and nanotechnology.

Structural Materials

This area features the relationships among the chemical and physical structure of materials and their properties and performance. Regardless of the material class—metallic, ceramic, polymeric, or composite—an understanding of the structure-property relationships provide a scientific basis for developing engineering materials for advanced applications. Fundamental and applied research in this field responds to an ever-increasing demand for improved or better-characterized materials.

Undergraduate Program

Students must complete a minimum of 120 units, with which they must satisfy the Berkeley and departmental requirements outlined in this bulletin. Full details on these requirements can be found in the *College of Engineering Announcement: A Guide to Undergraduate and Graduate Study* available online. (http://coe.berkeley.edu/students/college-of-engineering-announcement)

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5 Year BS/MS Program

The five-year combined Bachelor of Science/Master of Science program augments the existing four-year undergraduate program with a fifth year of graduate study that provides a professionally oriented component, preparing students for careers in engineering or engineering management within the business, government, and/or industrial sectors. In this

program, students earn a bachelor's degree and subsequently, a Master of Science degree under Plan II (without thesis) of the Academic Senate. This five-year program emphasizes interdisciplinary study through an independent project coupled to coursework. The program is open to undergraduate materials science and engineering majors (both single or joint majors) only.

Graduate Programs

Qualified holders of the bachelor's degree in fields such as materials science and engineering, ceramic engineering, metallurgy, physics, chemistry, and various fields of engineering disciplines can all successfully undertake graduate study in materials science.

A combination of coursework and research normally leads to the MS, MEng, and PhD degrees, qualifying the graduate for a wide range of positions in industry, governmental organizations, or universities that entail research or advanced engineering in the production, development, and use of materials. The coursework includes a core program in materials science and engineering, along with additional courses that provide breadth. MSE students may elect to follow the designated emphasis in nanoscale science and engineering, as described here. (http://nano.berkeley.edu/educational/DEGradGroup.html)

Topics for graduate research include studies in biomaterials; electronic, magnetic and optical materials; structural materials; chemical and electrochemical materials science and engineering; and computational materials science and engineering. A wide variety of facilities is available for processing, including thin film deposition by Molecular Beam Epitaxy, Pulsed Laser Deposition, and other physical and chemical deposition techniques. Techniques such as transmission and scanning electron microscopy, surface characterization, optical spectroscopies, electron paramagnetic resonance, electrical transport, microprobe X-ray emission spectroscopy, differential thermal analysis, precision calorimetry, and cryogenic and high temperature mechanical testing are used for fundamental characterization of the structure and properties of materials. Joint facilities in Berkeley's Microfabrication Laboratory, the Integrated Materials Laboratory, and Lawrence Berkeley National Laboratory, including the National Center for Electron Microscopy and the Advanced Light Source, can be used for graduate research.

MAT SCI 24 Freshman Seminar 1 Unit
Department: Materials Science and Engineering
Course level: Undergraduate
Terms course may be offered: Fall and spring
Grading: Offered for pass/not pass grade only.
Hours and format: 1 hour of lecture/discussion per week.
The Freshman Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small seminar setting. Freshman seminars are offered in all campus departments, and topics vary from department to department and semester to semester. Enrollment limited to 20 freshmen.

MAT SCI 39A Freshman/Sophomore Seminar 1.5 - 4 Units
Department: Materials Science and Engineering
Course level: Undergraduate
Terms course may be offered: Fall and spring
Grading: The grading option will be decided by the instructor when the class is offered.
Hours and format: 1 hour of seminar per week per unit for 14 weeks. 1.5 hours of seminar per week per unit for 10 weeks. 2 hours of seminar per week for 8 weeks. 2.5 hours of seminar per week for 6 weeks.
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollments limits are set by the faculty, but the suggested limit is 25.
Course may be repeated for credit when topic changes. Instructor: Sastry

MAT SCI 39B Freshman/Sophomore Seminar 1.5 - 4 Units
Department: Materials Science and Engineering
Course level: Undergraduate
Terms course may be offered: Fall and spring
Grading: The grading option will be decided by the instructor when the class is offered.
Hours and format: 1 hour of seminar per week per unit for 14 weeks. 1.5 hours of seminar per week per unit for 10 weeks. 2 hours of seminar per week for 8 weeks. 2.5 hours of seminar per week for 6 weeks.
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollments limits are set by the faculty, but the suggested limit is 25.
Course may be repeated for credit when topic changes.

MAT SCI 39C Freshman/Sophomore Seminar 1.5 - 4 Units
Department: Materials Science and Engineering
Course level: Undergraduate
Terms course may be offered: Fall and spring
Grading: The grading option will be decided by the instructor when the class is offered.
Hours and format: 1 hour of seminar per week per unit for 14 weeks. 1.5 hours of seminar per week per unit for 10 weeks. 2 hours of seminar per week for 8 weeks. 2.5 hours of seminar per week for 6 weeks.
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollments limits are set by the faculty, but the suggested limit is 25.
Course may be repeated for credit when topic changes.

MAT SCI 39D Freshman/Sophomore Seminar 1.5 - 4 Units
Department: Materials Science and Engineering
Course level: Undergraduate
Terms course may be offered: Fall and spring