Materials Science Minor

Students who wish to earn a minor in Materials Science and have it so designated on their transcript must successfully complete four courses (16 credits) as listed below. Only one of these courses may also count towards the requirements of a student's major or another minor. Applied Physics majors earn a concentration instead of a minor (the concentration adds a research capstone course to the requirements for a minor).

Required Courses:

· PHYS-342, Materials Science
· PHYS-362, Modern Physics (with lab)

Elective Courses (choose two):

· PHYS-474, Optoelectronics
· PHYS-442, Physics of Materials
· EE-426, Solid State Devices
· MFGG-507, Polymer Processing
· PHYS-542, Advanced Physics of Materials

Course Descriptions from the Catalog

Materials Science: (PHYS-342) A course describing the relation between the structure and properties of metals, semiconductors, ceramics and polymers, including topics related to smart materials. Important crystal structures, imperfections, defects and diffusion in metals and ceramics, and basic structural characteristics of polymers are discussed. Materials characterization methods of X-ray diffraction, spectroscopic and microscopic techniques are introduced. Basic thermal, electrical, magnetic, and optical properties of materials are covered in this course.

Modern Physics: (PHYS-362) This course is an overview of the discoveries and applications of physics from the early 20th century on. Topics include relativity, quantum phenomena, wave-particle duality, quantum physics, solid state physics, semiconductors and superconductors, and nuclear and particle physics. Laboratory experiments will accompany topics introduced in lecture.

Optoelectronics: (PHYS-474) Basic solid state concepts pertinent to optoelectronic devices, light modulators, display devices and systems, and fiber optics. Optical communication systems and integrated optics are covered. Demonstrations and experiments using optoelectronic devices and fiber optic communications systems are included.

Physics of Materials: (PHYS-442) This course is an in-depth study of on important physical properties of metals, semi-conductors, superconductors, and insulators, including thermal, electrical, magnetic and optical properties. Important topics covered in this course are the reciprocal lattice and momentum space, lattice vibrations, phonons and their effects on various properties of metals, energy band theory, effect of band diagrams on optical and electrical processes, superconductivity, dielectrics, ferroelectric, and ferromagnetic materials and behaviors.

Solid State Devices: (EE-426) Advanced concepts of electronic engineering are studied. Topics include: nonlinear circuits; active filters; pulse and switching circuits; integrated circuits; and digital electronic design.

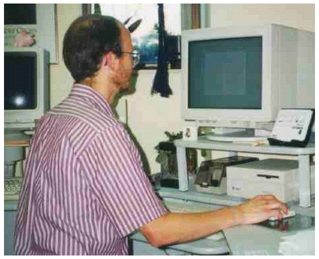
Polymer Processing: (MFGG-507) A study of how the structure and properties of polymeric materials are affected by processing parameters. Topics include nomenclature and manufacture of polymers, thermoplastics and thermosets, molecular architecture, amorphous and crystalline polymers, molecular weight and distributions, reinforcements and fillers, thermal transition, polymer melt rheology, material characterization and testing, viscoelastic behavior, composites, and environmental aspects of plastics. Major processing methods such as injection molding and extrusion are discussed. Screw and die characteristics, melt mechanism, components of molding machines, optimization of process parameters, and troubleshooting are presented. Other processes such as blow molding, thermoforming, rotational molding, casting, foaming, compression/transfer molding, composites and processes, radiation processes, and auxiliary equipment are briefly discussed. laboratory experiences focus on the effects of processing parameters on the stability and mechanical integrity of thermoplastic materials as well as the utilization of modern computer aided engineering in material selection, part/tooling/process design and manufacturing.

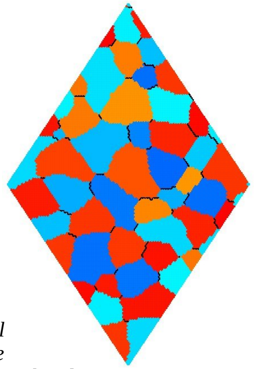
Advanced Physics of Materials: (PHYS-542) Topics covered in this course include growth, processing, characterization, and fabrications and applications. In-depth analysis of electrical, magnetic, and optical properties of materials will be discussed. Physics of various devices based on thin films, quantum wells, superlattice, and nano-structures will be included. Physical phenomena behind the semiconductors, electro-optic devices, detectors, actuators, high frequency devices, and magnetic devices will be discussed. Special topic projects including a literature search and presentation will be implemented in this course.

Materials Science Faculty at Work

Dr. Bahram Roughani *uses Raman spectroscopy to analyze the properties of thin layers (only a few atoms thick) of various materials with industrial and technological applications.*

Dr. Prem Vaishnava *specializes in Mðssbauer spectroscopy and high temperature superconducting materials.*



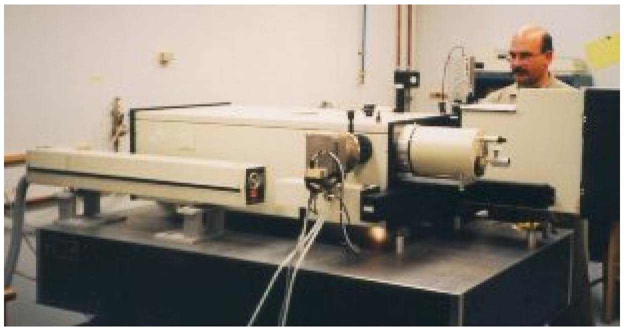


Dr. Greg Hassold *studies computational models of the evolution of polycrystalline materials. The image at right shows a simulated grain structure in a 2-phase microstructure (eg., solder).*

Materials Laboratory Facilities

Raman Spectroscopy Laboratory

The Raman spectroscopy laboratory at Kettering University is a state-of-the-art facility for optical characterization of various materials of interest for electronic, magnetic, optical, and optoelectronic applications. This Raman system is equipped with a Raman microprobe with spatial resolution of one micrometer, a double monochromator with electronic controller, a photomultiplier tube and photon counting system, an optical multichannel analyzer, an argon-ion laser source, and automated data acquisition capability. Interested Kettering students may contact professor Roughani to access this facility for research work on optical characterizations of advanced materials.

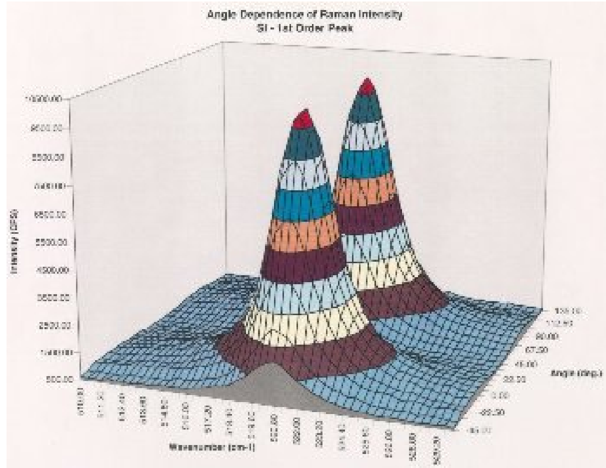


Photoluminescence Laboratory

A modern photoluminescence laboratory for characterizations of optical and electronic properties of materials is being developed, which compliments and enhances the existing capability in optical characterization of materials at Kettering University. This laboratory will be used for student and faculty research projects on advanced materials. Professor Ramabadran or professor Roughani may be contacted regarding this laboratory facility.

Mðssbauer Spectroscopy Laboratory

This laboratory is used to study nuclear resonance flourescence of materials, characterizing the magnetic properties of materials. Equipment in the lab is also used to create and study superconductor materials, especially materials which become superconductive at high temperatures.   Interested students may contact Prof. Vaishnava for details on this laboratory.



Kettering University's Raman spectrometer was recently used by David Warner (EE '99) and Dr. Bahram Roughani to collect the Raman spectra from a Silicon (Si) wafer. The Si sample was cleaved along the (110) crystal orientation. The 3-D plot above was obtained by rotating the sample in 7.5 degree increments. The variation of the polarization dependence Raman peak intensity displays the high sensitivity of the Raman technique in determining the lattice structure and symmetry of crystalline structures.

For More Information Contact:

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or visit our web page:

www.kettering.edu/acad/scimath/physics/matsci.html

Applied Physics

Materials Science Minor

Materials Science investigates the relationship between the structure and properties of materials. Progress in the use of materials has marked the civilization of mankind, from the Stone Age and Iron Age to our age of semiconductors and polymers. Materials science applies the analytical tools of physics as well as insights from chemistry and engineering (and even mathematics and computation) to forge this link between structure and properties. This link can lead to the improvement of the properties of known materials (such as steel or silicon), as well as new materials designed to meet new needs (superconductors, smart materials, nanostructural materials).   This knowledge is useful whenever material properties impact performance.

Students who have watched the recent rapid industrial progress in optoelectronics, nanofabrication, novel semiconductors, high temperature superconductors, and micro-electromechanical systems (MEMS) should find the materials science minor attractive. Studying materials science can be a bridge to a career in any of these emerging technologies. Take a look inside to see what a minor in Materials Science at Kettering University has to offer you.