MSE GRADUATE BROCHURE

BROCHURE INDEX

Introduction

Why Major in Materials Science and Engineering At UTK?

Developments in materials science and engineering are on the cutting edge of modern technology. New and improved materials are critical to the development of new products in the computer and electronic industries, artificial organs and limbs for the human body, as well as strong lightweight components for automobiles and aerospace systems. Materials science and engineering is a true interdisciplinary subject cutting across the traditional disciplines of engineering, the physical sciences, and even some areas of the life sciences. It calls for individuals able and willing to take a broad perspective and capable of handling interdisciplinary problems.

Students with graduate degrees in Materials Science and Engineering and in Polymer Engineering are in great demand and command high entrance salaries. Graduates from our programs at the University of Tennessee usually receive several competing offers from major companies. One recent Ph.D. in Polymer Engineering received offers from every interviewing company, fourteen in all! Typical recent starting salaries have been about $45,000 for M.S. graduates and about $55,000 for Ph.D. graduates.

The department has 14 full-time faculty and several adjunct faculty, many from the Oak Ridge National Laboratory (ORNL). Seven professors are Fellows in their respective professional societies, which range across the materials area and include the American Society for Metals, the American Physical Society, the Society of Plastics Engineers, and the American Institute of Chemical Engineers. One faculty member holds one of the University's Chairs of Excellence. Many of the faculty have received University and national professional awards for their research and teaching achievements. Typically, 50 to 60 full-time graduate students and five to seven visiting scholars, such as postdoctoral fellows and other research associates, participate in the program each term. A complete list of the faculty and their research interests can be found later in this brochure.

Most of our students receive full financial aid, either as research assistants on grants and contracts or as teaching assistants. Knoxville has a low cost of living when compared to most U.S. cities. In practical terms, typical stipends as of 1995 start at full tuition plus $12,000 per year for MS students and $14,000 per year for Ph.D. students and compare very favorably with those available to students located in more expensive areas of the country.

All potential students are advised to carefully investigate the cost of going to school at different colleges. You should take into account the cost of fees and the cost of living as well as the magnitude of the offer being made. For purposes of comparison, the following figures are provided, which have been taken from the Cost of Living Index for the 2nd quarter of 1994 [American Chamber of Commerce Researchers Association, 1994, vol. 27, no. 2]. The values given are expressed as a percentage of increased income that would be needed to live in these cities, relative to the Knoxville area.

Atlanta, GA	0 %
Boston, MA	42 %
Cleveland, OH	11 %
Jackson, MS	4 %
Los Angeles, CA	30 %
Philadelphia, PA	35 %
Raleigh, NC	4 %

To compare the difference, take a hypothetical graduate assistantship stipend at UTK of $12,000 as an example. To live in Boston at the same level, you would require a graduate assistantship stipend of $17,040.

U.T. Knoxville is located in a metropolitan area of over a half million people and ranks high on surveys that consider the quality of life. Downtown Knoxville is only a ten minute walk from the campus. Within an hour's drive are the Great Smoky Mountains National Park and six magnificent lakes of the Tennessee Valley Authority. Eastern Tennessee has a four seasons climate with winter temperatures cold enough for skiing in the nearby mountain resorts. There are regularly scheduled symphony concerts, opera and ballet in Knoxville, as well as a nationally recognized theater on campus.

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Who Should Apply to a Materials Graduate Program?

Few students have undergraduate degrees in materials engineering or polymer science and engineering, so most applicants come from other disciplines, primarily from engineering or the physical sciences. Students with undergraduate degrees in chemical, metallurgical, mechanical, and electrical engineering or engineering science and mechanics are particularly well-suited for the program. Students from physics and chemistry, particularly condensed matter physics and physical chemistry, are strongly encouraged to pursue careers in materials. No student is expected to have prior experience in all subject areas, and courses are structured to accommodate a wide variety of backgrounds.

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Admission and Financial Aid

Applications for admission to graduate study in the Department of Materials Science and Engineering are processed throughout the year. Students may enroll at the beginning of any academic term, but entry in the fall is preferred. Admission is administered by the Graduate School and special restrictions may apply to foreign applicants. For a Graduate School application, the current tuition and fee scale, and additional information about the University of Tennessee, Knoxville graduate education programs, write:

The Office of Graduate Admissions and Records
218 Student Services Building
The University of Tennessee, Knoxville
Knoxville, TN 37996-0220

Most students receive financial aid in the form of fellowships, teaching assistantships or graduate research assistantships. The majority of the financial support comes from departmental sources, but a few University-wide fellowships are awarded to students of exceptional ability. Special minority fellowships are available to residents of the state of Tennessee. Fellowship information may be obtained from the Graduate School. For information and application forms for departmental financial aid, write to:

Graduate Chairman
Materials Science and Engineering
414 Ferris Hall
The University of Tennessee, Knoxville
Knoxville, TN 37996-2100

or e-mail.

Please specify whether your interests are primarily in metallic, ceramic, polymeric or composite materials.

In considering applications, prime attention is paid to the academic record of the students with special consideration being applied to the grades received for courses taken in the major during the last two years of the undergraduate study. In the case of students having a master's degree from another institution, attention is paid to the graduate record, the thesis and published papers. In all cases, letters of reference are of considerable importance. For students not having pursued an American or American-style education, the GRE test results are requested. A good record is expected in all parts of the examination, but particular attention is given to the quantitative section where a minimum ninetieth percentile is required. In general, an undergraduate grade point average of 3.0 is expected, but consideration is also given to students having a lower GPA if the grades during the senior year have been significantly better than those of earlier years. As mentioned earlier in the brochure, students are considered from all scientific and engineering disciplines. An undergraduate degree in materials science and engineering is not required. Admission and financial aid requests are considered by departmental committees and applications should be completed early in the calendar year. For foreign students, the university sets a deadline, but applications from American students may be received at any time.

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Academic Programs

Programs leading to graduate degrees (either MS or Ph.D.) are available in materials science and engineering and in polymer engineering. Both are broadly structured and cover a variety of topics in the materials area. Special programs also are available in related topics, such as ceramics, composites, and electronic materials. Detailed course descriptions can be found in the Graduate Catalog.

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Housing

The University offers a variety of housing for both single and married students. Approximately 7,000 of UT Knoxville's 25,000 students live on campus in residence halls and in an apartment building for single students. Two high-rise towers offering married student housing are located adjacent to the campus.

University-owned housing for student families is available in residential areas of the city and is served by campus shuttle buses. An off-campus housing office also is available to assist those who wish to live in non-University housing. For information on housing in University residence halls, married student apartments, or rental properties, contact:

Office of Rental Property
474 S. Stadium Hall
The University of Tennessee, Knoxville
Knoxville, TN 37996
(423) 974-3431

or

Residence Halls
405 Student Services Building
The University of Tennessee, Knoxville
Knoxville, TN 37996
(423) 974-3411

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Research Areas

The Department of Materials Science and Engineering focuses its research programs in the areas of metals, polymers, ceramics and composites. Graduate students participate in this research through their MS theses and Ph.D. dissertations.

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Metals

Research on metals and alloys was one of the first established research activities in the University's College of Engineering. Current research concentrates on metallurgical processing, corrosion science, surface modification, physical metallurgy, mechanical behavior, and welding and joining.

Metallurgical processing involves development of processing techniques for metals and alloys in both liquid and solid states to enhance their properties through changes in chemistry and microstructure. The classical areas of refining, melting, casting, hot and cold working, heat treating, gas-metal interactions, powder processing, and welding are included here, together with such specialty areas as crystal growth, formation of composites through directional solidification, vapor deposition, and rapid solidification processing. Through the years, research has been carried out in all of these areas. Current research programs emphasize the directional solidification and oriented crystal growth of high-temperature intermetallic alloys, and the development of special properties through rapid solidification processing.

Performance of materials in hostile environments is frequently determined by the substance's corrosion resistance. The Department of Materials Science and Engineering maintains a state-of-the-art corrosion laboratory, which supports ongoing research in the evaluation, understanding, and prevention of corrosion, and its detrimental effects on an alloy's mechanical and physical properties.

Investigation of iron-and nickel-base alloys in a variety of environments and studies of materials for exotic applications, such as surgical implants,

are of growing interest in the department. Cooperative work in this field is being done with the Oak Ridge National Laboratory.

Surface modification involves preparation of materials with improved surface-related properties through treatments that change the composition or structure of a region near the surface. Ion implantation and laser annealing are two techniques currently under intensive study. Ion implantation allows the composition of a near- surface layer to be modified and controlled independent of phase equilibria. Laser annealing produces non-equilibrium surfaces without change in composition. Applications of these techniques include surface hardening of tools, improvement of the lifetime of surgical implants, and processing of electronic materials.

Materials joining and welding processes are essential for virtually all engineering applications from power generation, buildings, bridges, automotive, aeronautical and processing equipment just to state the obvious. The use of the newer engineered materials, such as carbon-carbon composites, metal-matrix composites and ceramics, is severely limited by the lack of suitable joining methods. The properties of welded joints and the associated heat affected zones are significant areas of endeavor for the Materials Joining Group. The physical metallurgy and material response of the joints are emphasized and the effects of defects and discontinuities on the performance are a primary area of research. The development of new processes, testing methods and close interaction with industry have been hallmarks of joining research at Tennessee for over 25 years. The graduates of the joining program are active in all industries and have found the research satisfying and important in their professional development.

Detailed studies of physical metallurgy and mechanical behavior complement those programs mentioned above. Research in physical metallurgy centers around studies of crystallography, alloying behavior, phase transformation, thermodynamic properties, microstructural stability, preferred orientation, and materials characterization by optical and electron microscopy, x-ray diffraction, and physical properties. Theory is combined with experiment to confirm mechanisms and fundamental principles. Vigorous mechanical studies include mechanistic understanding of fatigue and fracture behavior, characterization of a material's response to a variety of loading conditions, analysis of fracture and other failures, and studies of formability and anisotropy. In particular, high-temperature mechanical behavior of superalloys and intermetallics including deformation and creep-fatigue crack growth rate properties, has been extensively investigated. Moreover, a state-of-the-art high-temperature, electro-hydraulic machine has been set up for evaluating fatigue and fracture behavior at temperatures as high as 2000 deg. C. Remaining life prediction technology has been developed to assess the life of in-service, elevated-temperature structural components.

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Polymers

A primary advantage of polymeric materials over other substances is their ability to be economically processed into a variety of useful shapes and products. Further, the properties of polymers can vary greatly, depending upon the way they are processed. Polyethylene, for example, can be prepared as a soft, pliable plastic or as a fiber with strength exceeding that of steel. This makes polymer processing and its relation to the structure and properties of the final product one of the most important areas of polymer science and engineering and a main theme of research at the University of Tennessee. UT Knoxville faculty members are internationally known for their experimental and theoretical studies of polymer processing and structure development.

Successful processing of polymers frequently depends on a detailed understanding of polymer melt flow or rheological behavior. This research extends to polymer blends and polymers reinforced by particulates and fibers. Characterization of polymer structures at both the molecular and supermolecular levels and evaluation of the relationship of structure to mechanical and physical properties of processed materials is another research specialty at UT Knoxville. Light scattering, differential scanning calorimetry, dynamic mechanical analysis, transmission and scanning electron microscopy, wide-and-small angle x-ray scattering, neutron scattering, Fourier transform infrared spectroscopy, and other specialized techniques are used in these investigations.

Formation of fibers, films, and moldings from polymer melts makes up some of the most important polymer processing operations, and it has important applications in the textile, automotive, aerospace, medical, computer, and packaging industries. Basic research in these areas has been underway at the University of Tennessee, Knoxville for more than two decades. This work includes fundamental investigations of dynamics, rheology and crystallization kinetics, and studies on how processing produces the final molecular orientation, morphology, and the properties of fibers, film or moldings. Emphasis is given to the influence of resin characteristics, such as molecular architecture, molecular weight distribution, and the role of additives on both the processibility and final properties. Mathematical modeling or computer simulation is an important aspect of this research.

A growing area of research is that of aging and degradation of polymers. This is an important subject relevant to the development of innovative use of polymers, prediction of lifetimes of products and ecological impact.

Other research programs on polymers include processing of specialty polymers, such as thermoplastic elastomers and polymer liquid crystals, solid-state processing, to develop exceptional mechanical properties, and basic studies of polymer alloys and blends.

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Electronic Materials and Ceramics

Electronic materials, starting from the development of the transistor around 1950, have provided some of the most important technological advances of the second half of the 20th century. Research in areas, such as optoelectronics, the integration on a silicon chip of communications and logic operations, and optical computers and information storage media, ensures a continued growth of the electronic materials field well into the 21st century. Research in electronic materials is conducted using laboratory facilities at both the University of Tennessee and in the Solid State Division of ORNL. These studies are characterized by the search for novel materials synthesis and processing techniques and by the need to understand the physical and chemical principles that rule and enable these new methods. The latter goal is accomplished by the use of a number of powerful analytical techniques.

A very active research program is pursued in the growth of high quality epitaxial thin films of high-temperature superconductors, compound semiconductors, oxide ceramics, and metals. Semiconductor photovoltaic materials, for fabrication of low-cost and/or high-efficiency thin-film solar cells, are a particularly strong area of interest. Another area of pioneering research activity is the pulsed-laser activation process that makes possible electroless deposition of metals on ceramic substrates that are relevant to electronic packaging. Related research also is performed on pulsed-laser and thermal processing methods, and underlying basic physical mechanisms to improve the bonding between metals and ceramics. Other front-line research includes the enhancement and design of specific materials properties, or unusual combinations of properties, through epitaxial growth of multilayered quantum well and superlattice structures whose useful properties are dominated by purely quantum mechanical effects that result from quantum confinement and reduced dimensionality. This approach is used for both compound semiconductor and high-Tc superconductor materials.

Thin film growth facilities include one of the best equipped laboratories in the world for deposition by pulsed laser ablation, together with in situ, time-resolved analysis capabilities, at ORNL. Low-energy ion beams also are used to assist other film deposition methods, as well as for direct sputter-deposition of films. Thick films are grown using electroless deposition techniques. Analytical techniques currently in use, and for which training is provided either directly or through collaborations, include cross-sectional high resolution and conventional electron microscopes, scanning tunneling microscopy, x-ray diffraction (especially for thin films), Auger emission spectroscopy, and x-ray photoelectron spectroscopy.

The newest of research interests for the Department of Materials Science and Engineering is greatly strengthened by the international reputation and outstanding facilities of the Oak Ridge National Laboratory. University students and faculty have access to ORNL ceramics facilities through cooperative research arrangements.

Departmental ceramics research currently focuses on surface modification of ceramics by ion beams, near-surface mechanical properties and properties of diamond films, development of high-temperature ceramic materials, ceramic glasses, development of ceramic fibers from polymer precursors, microwave processing of ceramics and fabrication of intermetallic-bonded ceramic materials. Significant energy savings during the sintering and joining of ceramics are being realized by microwave heating techniques. Furthermore, manufacturing and characterization of ceramic coatings are being investigated for high-temperature aerospace applications in cooperation with ORNL.

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Composites

One of the most fascinating and growing areas of materials science is that of composite materials in which two or more of the basic classes of materials are brought together in a special way to generate properties that cannot be produced from a single material. Materials studied include metal-matrix, in situ intermetallic-matrix, polymer-matrix and ceramic-matrix composites. Strong interests in composites within the department range from special metal-matrix composites, such as titanium carbide reinforced titanium composites, to continuous fiber reinforced ceramic composites used in gas cleaning filters and to continuously wound carbon fiber reinforced plastics. Process modeling, interface engineering and mechanical behavior of composites are emphasized in the vigorous composites research endeavor within the department. Furthermore, analytical and numerical modeling of the mechanical behavior is being conducted on composite materials. A composites specialty is available in all of our graduate degree programs. A series of composites courses are available, that are taken by students in both polymer and metallurgical engineering.

Courses offered cover a wide range of topics in composites and some are co-taught by adjunct faculty from the Oak Ridge National Laboratory. The research projects available cover the whole range of composites interests from design and synthesis of special alloys and polymeric matrices to theory of fracture mechanics. A general theme being stressed in all parts of the program is the materials science of composites. All students will obtain experience in laboratory methods, processing of composites and in their characterization and testing. The philosophy being applied is that major developments in composites processing, manufacture and reliability can come only from individuals educated in all aspects of the field.

Research projects are supervised directly by members of the faculty of the University of Tennessee, but many projects are interactive with scientists at the Oak Ridge National Laboratory and some of the research is conducted by the students at Oak Ridge. By this means the students are exposed to a rigorous academic degree program while at the same time becoming familiar and participating in leading edge research of national significance.

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Materials Joining and Welding

The Materials Joining and Welding Research Group has been active within the Department since 1968. The Group is one of only 5 dedicated graduate joining research programs in academia. The current programs are derived from industrial consortia, technical associations and government. The Group is composted of graduate students, visiting professors and visiting scholars from around the world. Extensive international cooperation with Welding Institutes and Universities in Japan, China and Austria has been a characteristic of the research.

The components of joining research are directed at the basic understanding of the microstructural aspects of joints in a wide variety of materials, engineering properties of welded joints and the development of test methods to define material response. The Group has been responsible for developing several new welding tests and the development of equipment for the characterization of welds. The Group publishes widely and is sought out for technical programs throughout the world.

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Research Support

Materials research at UT Knoxville receives its support from industry and from agencies, such as the National Science Foundation, the Department of Defense, the Department of Energy and the Electrical Power Research Institute. The State of Tennessee provides significant support through Centers of Excellence funding to the Center for Materials Processing. In recent years, industrial support has come from:

3M	Martin Marietta
ALCOA	Materials Properties Council
Allied Signal Corporation	Monsanto
ARCO Chemical	Nickel Development Institute
Boeing Tennessee	Plastics Institute of America
Cabot Corporation	Pressure Vessel Research Council
Detroit Edison Company	Procter & Gamble
Dow Chemical	Ravenswood Aluminum Company
Du Pont	Rhone-Poulenc
Eastman Chemicals	Rohm & Haas
Exxon	Shell Development Company
Haynes International	Steel Founders Society of America

Hercules, Inc.	Union Carbide
Hoechest Celanese	Welding Research Council
IBM	Westinghouse Electric Corporation
Jentek Sensors, Inc.	

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Resources and Facilities

Offices and primary research facilities for the Department of Materials Science and Engineering are located in the Ferris Hall building - one of six major engineering buildings on campus. Located in the Nathan W. Dougherty Engineering building and in the Science and Engineering Research Facility building, general materials science laboratories include:

- metallography and optical microscopy
- transmission and scanning electron microscopy
- x-ray diffraction
- low and high temperature calorimetry
- physical properties evaluation
- mechanical properties testing

The "Science and Engineering" building was constructed to house most of the above facilities. The building provides a total of approximately 100,000 square feet of research space. In addition, Metallurgical Engineering maintains laboratories for melting and solidification, crystal growth, corrosion testing, mechanical testing, chemical metallurgy and thermodynamics, nondestructive evaluation, heat treating, mechanical shaping, fabrication, welding and joining.

Polymer engineering has additional laboratories for molecular and rheological characterization, polymer mechanical and electrical testing, and complete optical evaluation. These laboratories are complemented by special polymer facilities for fiber processing, molding and extrusion, and film processing.

An abbreviated listing of major experimental areas and equipment can be found at the back of this publication.

A strength of the University's materials science and engineering research efforts is its comprehensive machine and electronics shops, which are staffed by 10 skilled technicians. These shops work with graduate students and professors to design and build new equipment, as well as maintain the department's sophisticated research equipment.

Advanced computing facilities are available through the College of Engineering and the University of Tennessee Computing Center. Several IBM mainframes and VAXclusters are available, and the Department of Materials Science and Engineering maintains a fully equipped microcomputer laboratory.

Academic and research ties with the Oak Ridge National Laboratory, located just 25 miles from campus, provide additional facilities and resources to UT Knoxville students and faculty. Examples include surface modification and characterization laboratories, small angle x-ray and neutron scattering facilities, analytical electron microscopy, and ceramic composites and ceramic processing, and high-temperature mechanical testing, and characterization facilities.

The University's main library, one of the most technologically advanced research libraries in the nation, supports scholarship in all academic disciplines, and the technical collections in materials science at the Oak Ridge National Laboratory are among the finest in the world.

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Related Programs

Because of the interdisciplinary nature of materials research, frequent interaction occurs between faculty and students in Materials Science and Engineering and other University academic programs. For example, a polymer group in the Department of Chemistry supplements the Polymer Engineering Program. Cooperative research in textiles and nonwoven materials is being done by Polymer Engineering and the Department of Textiles, Merchandising and Design in the College of Human Ecology. Similar relationships exist between the various programs in materials science and engineering and other programs, especially in chemical engineering.

The College of Engineering has two interdisciplinary research centers that support the materials science program. These are: 1) the Center for Materials Processing, and 2) the Measurement and Control Engineering Center. In addition, a strong interaction on composite research has been developed between Materials Science and Engineering, and Mechanical Engineering Departments.

The Center for Materials Processing is supported by the State of Tennessee's "Centers of Excellence" program, part of the innovative Better Schools Program. Corporate sponsors also provide support and share in the research findings. The Center brings together individuals from across the campus who have the capabilities and interest in carrying out research in the processing of materials. These persons are located in several science and engineering programs, but the activities of the Department of Materials Science and Engineering represent the major component of this Center. In return, the Center provides significant support for the research of departmental faculty and graduate students.

The Measurement and Control Engineering Center offers the only comprehensive, interdisciplinary education and research program in this field in the United States.

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List of Major Departmental Equipment

Microstructural and Morphological Characterization

-
- Transmission Electron Microscope
- Scanning Electron Microscopes with EDS
- Differential Scanning Calorimeter
- Fully Automated X-ray Diffractometers with Auxiliary Computers, Graphics Terminal, Magnetic Tape Drive, Digital Plotter, and Disc Drives
- Transmission and Reflection Optical Microscopes with Melting Hot Stages and High-pressure Hot Stages
- Metallographs, Sample Preparation and Photographic Facilities
- Multiaxial Birefringence Measurement Apparatus
- Laser (Small Angle) Light Scattering Apparatus (Computer Operated)
- Automated Rheovibron
- Fourier Transform Infrared Spectrometer

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Mechanical, Rheological and Electrical Property Test Facilities

-
- MTS (Material Test System) Electro-hydraulic Machine Capable of 2000 deg. C. Fatigue and Fracture Testing in Vacuum and Inert Gaseous Environments
- Questar Crack Observation System
- Krak gage/Fractomat Crack Detection System
- Interlaken Electro-hydraulic Machine (22 kip capacity)
- Interlaken Electro-hydraulic Machine (220 kip capacity)
- Impact and Creep Testing Facilities
- Universal Mechanical Testing Units with Capillary Rheometer
- Rheometrics Mechanical Spectrometer
- Uniaxial Elongational Viscometer
- Dielectric Bridge with High-pressure Attachment
- Electrical Aging Equipment for Studies of Dielectric Breakdown

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Corrosion Test Facilities

-
- Computer-controlled Potentiostat Systems
- Automated Multichannel Electrometer Systems
- Atomic Absorption Spectrophotometer
- Stress Corrosion Test Facilities

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Melting, Casting and Related Processing Equipment

- Levitation Zone Refiner
- Lepel 35 KVA, 450 kHz Induction Heating Unit
- Hammer and Anvil Splat Cooler for Rapid Solidification Studies of Metastable Materials

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Materials Joining and Welding Equipment

-
- 750 amp Fully Programmable Airco Sampac Welding Station with AVC and Dual Wire Feed1200 amp Linde Submerged Arc Welding Station
- 300 VPS Plasma ARC Supply
-
- Astro ARC Automatic Pipe and Tube Welder
- 3000°C Vacuum Furnace and Inert Atmosphere Furnace
- GMAW, FCAW and Pulsed Arc Power Supplies
- ESAB Robotics Welder
- 300 Vacuum and Inert Atmosphere Furnace
- Miller Maxtronix 450 GMAW Welder

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Materials Joining and Welding Research Support Equipment

-
- Implant Tester for Hydrogen Cracking Sensitivity Testing
- TEC 910 Acoustic Emission Instrumentation
- Andrex 300 KV 6 mA X-Ray Radiography System
-
- Weld Thermal Cycle Simulation Unit (Gleeble 1500)
- Varestraint Hot Cracking Apparatus
- Nanochem Gas Purifier
- Prevew Test Apparatus
- Slow Strain Rate Testing Device
- Esab/Orlican Hydrogen Analyzer

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Polymer/Fiber Processing Facilities

- Stretch Blow Molding Machine
- Complete Synthetic Fiber Processing Facilities including Fourne 1/2 inch Screw Extender
- Screw Extruder (Rainville, 1 inch) with Tubular Film and Blow Molding Attachments
- Wet Spinning Apparatus; Pump, Extrusion System, Coagulation Bath and Take Up
- Blending and Mixing Extruder
- Biaxial Film Stretching Apparatus
- Wire Coating Extruder with in situ Curing Line
- Hughes Thermal Imaging System

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Graduate Courses in Materials Science and Engineering

- 405 Structural Characterization of Materials
- 421 Mechanical Metallurgy
- 422 Chemical Process Metallurgy
- 425 Metallurgical Applications in Manufacturing and Processing
- 443 Polymer Processing
- 444 Plastics Fabrication and Design
- 470 Environmental Degradation of Materials
- 471 Semiconductor Materials
- 472 Fundamental Principles of Composite Materials
- 474 Biomaterials
- 475 Fracture-Safe Design
- 505 Engineering Analysis
- 522 Defects in Crystals
- 523 Plastic Deformation of Metals
- 524 Metallurgical Thermodynamics
- 525-26 Welding Metallurgy

- 529 Diffusion in Solids
- 530 Phase Transformations in Metallic Materials
- 531 Advanced Corrosion
- 532 Metallurgy of Deformation and Fracture
- 540 Basic Polymer Chemistry
- 541 Fluid Mechanics and Polymer Processing
- 542 Further Topics in Polymer Processing
- 543 Basic Polymer Physics
- 544 Polymer Solution Thermodynamics and Characterization
- 546 Mechanical Properties of Solid Polymers
- 549-50 Laboratory Methods in Polymer Engineering
- 560 Principles of Ceramic Processing
- 561 Inorganic Glass Forming Systems
- 562 Experimental Mechanics of Composite Materials
- 570 Chemical Thermodynamics
- 571 Electron Microscopy
- 572 X-ray Diffraction
- 573 Biomaterials Analysis and Development
- 574 Formability of Materials
- 576-77 Special Topics in Materials Science and Engineering
- 621-22 Theoretical Metallurgy
- 623-24 Solidification and Crystal Growth
- 641 Advanced Rheology and Viscoelastic Theory
- 642 Advanced Topics in Polymer Processing
- 643 Phase Transformations in Polymers
- 671 Quantitative Microscopy
- 672 Advanced High Performance Fiber Composite Materials
- 676-77 Advanced Topics in Materials Science and Engineering
- 678-79 Seminar in Recent Advances in Materials Science and Engineering

***See Graduate Catalog for course descriptions**

directed to the Office of the Affirmative Action Director.

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- Materials Science and Engineering

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