Department of Materials Science and Engineering

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The Department of Materials Science and Engineering addresses the educational and technological challenges of creating, applying and characterizing new materials for manufacturing products for the 21st century. The department is committed to training students at the graduate level in all aspects of modern materials including metals, ceramics, polymers, electronic and optical materials, and materials characterization. Students have opportunities for hands-on research with modern equipment and facilities. The department has strong collaborative programs with other universities in the Dallas–Fort Worth region and with corporations throughout the world. Students have many opportunities to develop highly marketable skills for high-technology companies in electronics, chemical, electric power, automotive, aviation, biomedical and environmental industries, as well as academia.

Financial Support

Teaching assistantships funded by the department and research assistantships funded by individual faculty research grants support the majority of students. Out-of-state and international students who are funded at least half-time are eligible for in-state tuition rates. Contact the chair of the Department of Materials Science and Engineering regarding assistantships. Contact Student Financial Aid and Scholarships for student loan information.

Research

The **Electron and Ion Microscopy Laboratory** houses the new FEI TF20ST analytical high-resolution transmission electron microscope and the FEI Nova 200 Nanolab dual-beam scanning electron microscope/focused ion beam instrument. Recent acquisitions include a 3D local electrode atom probe tomography system, an environmental scanning electron microscope and a high resolution X-ray diffraction system, an atomic force microscope, and a UV-VIS ellipsometer. Full optical microscopy, sample preparation, and electron microscopy computer simulation facilities are available. The multi-disciplinary, multi-user laboratory emphasizes the production and characterization of nanoscale materials and devices and the transfer of technology to industry.

The **Laboratory of Advanced Polymers and Optimized Materials (LAPOM)** focuses on the development of materials with improved mechanical, tribological and thermo-physical properties, including thermoplastics, thermosets, composites, nanohybrids and coatings. High strength, wide service temperature range, low thermal expansivity, low static and dynamic surface friction, high adhesion of coatings to ceramic and metal substrates, high scratch, wear and mar resistance.
The analytical characterization facilities include a new 200kV Tecnai G20 analytical high-resolution transmission electron microscope with EDS, PEELS, energy filter and HAADF; a new dual beam Nova 200 focused ionbeam/field emission SEM; a Phillips 420 TEM with EDS; a JEOL 5800 scanning electron microscope (SEM) with EDS; a JEOL T-300 SEM; and a Scintag x-ray diffractometer.

The **Polymer Mechanical and Rheological Laboratory** is engaged in investigations of interrelationships between morphology and mechanical properties through the influences of time and temperature of polymers, composites and hybrid organic-inorganic nanocomposites. A Mechanical Testing System (MTS810) equipped with an environmental chamber (-150° to 600° C), video and thermal wave imaging provide stress pattern-temperature relationships around propagating cracks and estimate residual stresses. A Torsional Rheometer provides visuelastic and rheological property evaluation. Reliability of dielectric property retention is being examined through simultaneous effects of radiation and electrical fields using thermally stimulated depolarization currents and thermoluminescence.

The **Materials Synthesis and Processing Laboratory** has research interests focused on the development of aerogels and other novel ceramics for dielectric, sensor and high temperature

applications. A complete synthesis laboratory is available with several spin coaters for thin film development and with a BET surface area/pore size analyzer for structural characterization as well as high temperature furnaces and a critical point dryer.

The **Laboratory for Electronic Materials and Devices** is a cross-disciplinary laboratory performing basic and applied research on novel materials for advanced electronic devices of all kinds. The laboratory includes a Group IV molecular beam epitaxy system, a 3 MV ion beam accelerator, a comprehensive surface science system and several scanning probe microscopes. The primary areas of research include advanced dielectric materials, high electric field chemical reactions and molecular electronic devices.

The **Advanced Materials Laboratory** has research focused on the structure-property-processing relationships in metallic structural materials. Current investigations are in the areas of bulk metallic glasses; nanocrystalline materials; development of better aluminum, titanium and nickel alloys for structure applications; and shape memory alloys. Emphasis is on advanced processing and characterization.

The **Energy Materials Laboratory** is focused on developing new materials for advanced energy needs. Of particular interest are processing of nanoscale fuel cells, low-K dielectrics, optoelectronics using precursors, sol-gel and colloidal processing with an emphasis on advanced characterization techniques.

Additional Research Support

Federal support of research projects in the department includes funding from the Defense Advanced Research Projects Agency, the National Science Foundation, the Naval Research Labs, the Army Research Laboratory, U.S. Air Force Office of Scientific Research, U.S. Army Soldier Systems Center and the Department of Education. Other research support has been granted by the Texas Advanced Research Program, the Texas Advanced Technology Program, the Texas Energy Research in Applications Program, Texas Instruments, the Baylor College of Dentistry, Texas Utilities Electric, Bell Helicopter-Textron, Ford Motor Co., Eastman Kodak, General Motors, Sematech, Semiconductor Research Corporation, LTV Corporation, Viratech Thin Films and many small high-technology companies in the Dallas–Fort Worth region. Current funding sources include Carbon Nanotechnologies Inc., NASA, Army Soldier systems, The Naval Research Laboratory, the Army Research Office, Zyvex, Semiconductor Research Corporation, the Texas Advanced Research Program and the Texas Advanced Technology Program.

Admission Requirements

The student must apply for and be granted admission through the office of the dean of the Toulouse School of Graduate Studies; admission requirements applicable to all departments are found in the Admission section of this catalog or at *www.gradschool.unt.edu*. Students may also contact the program for current admission requirements.

Admission to the graduate degree programs in materials science is competitive, as available facilities do not permit admission of all qualified applicants. Departmental forms for applying for financial aid may be obtained from the chair of the Department of Materials Science and Engineering or from the web site (*www.mtsc.unt.edu/03ProspectiveStudents/Graduate.htm*). Students currently enrolled in MS degrees (other than materials science) at UNT should apply through the graduate school for admission to the Department of Materials Science and Engineering. Candidates applying for a concurrent degree need not resubmit original documents. Application does not imply admission.

Applying is a two-part process. First, prospective applicants for graduate degree programs must obtain and file an application for admission to the UNT graduate school from the graduate dean's office. Second, applicants for graduate materials science degrees must submit a complete copy of the graduate school application, GRE scores, TOEFL scores (if required), original college transcripts, a curriculum vitae, statement of research interests and at least two recommendation letters. If original GRE and TOEFL scores have been sent to the graduate school, a copy of scores can be sent to the department. If financial assistance in the form of a research or teaching assistantship is being sought, this should be requested in a cover letter to the department or by filling out the online request form at *www.mtsc.unt.edu/03ProspectiveStudents/Graduate.htm*.

Admission to the MS (problems-in-lieu-of thesis), MS (thesis) and PhD programs are based on a cumulative assessment of GRE, letters of recommendation and college transcripts. For admission, students must present competitive scores on the Graduate Record Examination (GRE). Contact the department or the Toulouse School of Graduate Studies concerning standardized admission test requirements. International applicants must also provide a minimum of 550 (paper) or 213 (computer based) or 80 (Internet based) on the TOEFL (Test of English as a Foreign Language) exam. Complete college transcripts and two letters of recommendation are required. Further details may be obtained from the departmental office.

Degree Programs

The Department of Materials Science and Engineering offers graduate programs leading to the following degrees:

- Master of Science and
- Doctor of Philosophy, both with a major in materials science and engineering.

Master's Degree Options

The applicant seeking a master's degree with a major in materials science and engineering will plan a degree program with the assistance of the student's major professor and the advisory committee. A graduate major must present credit for at least 32 semester credit hours. The student must maintain a B average in all courses.

Option 1, Master of Science, Thesis

The applicant seeking a master's degree with a major in materials science and engineering will plan a degree program with the assistance of the student's major professor and the advisory committee. A graduate major must present credit for at least 32 semester credit hours. The student must maintain a B average in all MTSE courses.

1. **Core Courses** (12 hours)

- MTSE 5000, Thermodynamics of Materials
- MTSE 5010, Bonding, Structure and Crystallography
- MTSE 5500, Electronic, Optical and Magnetic Materials
- MTSE 6100, Mechanical Properties of Materials

2. **Electives** (12 hours)

Twelve hours may be chosen from materials science or related fields, as approved by the major professor and the advisory committee.

3. **Seminar in Materials Science and Engineering** (2 hours minimum)

- MTSE 5700, Seminar in Materials Science and Engineering

Please see "Seminar in Current Topics in Materials Science" below.

4. **Thesis** (6 hours minimum)

- MTSE 5950, Master's Thesis

Work for the master's thesis is comprised of independent and original studies that may be experimental, computational, theoretical or a combination of these. As part of these requirements, the student must present a formal written report that must be approved by the major professor and the advisory committee and filed in the graduate dean's office. Reports for MTSE 5950 must be submitted in a form prescribed by one of the common refereed materials science journals, such as the manuscript form of the American Institute of Physics (see AIP style manual, current edition). See also the graduate school thesis requirements at *www.gradschool.unt.edu.*

Option 2, Master of Science, Problems in Lieu of Thesis

The graduate credit requirement for the Master of Science degree is 35 semester hours chosen in the following manner.

1. **Core Courses** (12 hours)

- MTSE 5000, Thermodynamics of Materials
- MTSE 5010, Bonding, Structure and Crystallography
- MTSE 5500, Electronic, Optical and Magnetic Materials
- MTSE 6100, Mechanical Properties of Materials

2. **Electives** (12 hours)

Fifteen hours may be chosen from materials science or related fields, as approved by the major professor and the advisory committee.

3. **Seminar in Materials Science and Engineering** (2 hours minimum)

- MTSE 5700, Seminar in Materials Science and Engineering

Please see "Seminar in Current Topics in Materials Science" below.

4. **Problem in Lieu of Thesis** (6 hours)

- MTSE 5920, Research Problems in Lieu of Thesis
- MTSE 5930, Research Problems in Lieu of Thesis

Research problems in lieu of thesis are independent, original studies that may be experimental, computational, theoretical or a combination of these. As part of the requirements for each problems course, the student must present a formal written report of the work done in the course, which must be approved by the major professor and the advisory committee. Reports for MTSE 5920-5930 must be submitted in a form prescribed by one of the common refereed materials science journals, for example, in the manuscript form prescribed by the American Institute of Physics (see AIP style manual, current edition).

Seminar in Current Topics in Materials Science

All MS (thesis) and PhD students are expected to attend MTSE 5700 during each term/semester of full-time graduate study. Candidates for a Master of Science (thesis) degree must present their work during the regularly scheduled departmental seminar prior to the oral examination before the graduate committee. Candidates for the Master of Science (problems in lieu of thesis) must give a seminar

based on the reports written for MTSE 5920-5930 and obtain a minimum grade of B for the seminar. The thesis/problem advisor must be present for the seminar presentation.

Examinations

An entrance interview and proficiency examination concerning fundamental materials science is required of all students. The results are used for advisory, placement and remedial purposes.

An oral presentation of the master's thesis is required. A decision on acceptance of the thesis is made by the student's advisory committee after an oral examination is successfully completed. A decision on the acceptance of a written report based on problems in lieu of thesis is made by the student's advisory committee. Guidelines for thesis preparation are available from the department secretary. See also the graduate school requirements at *www.gradschool.unt.edu*.

Doctor of Philosophy

The Doctor of Philosophy degree represents the attainment of a high level of scholarship and achievement in independent research that culminates in the completion of a dissertation of original scientific merit. Hence, it cannot be prescribed in terms of a fixed semester credit hour requirement.

Generally, the degree consists of 90 semester credit hours beyond a bachelor's degree and 60 hours beyond the master's degree, with 12 semester credit hours allocated for the dissertation.

It is expected that the candidate will have published at least one original research article in a refereed journal prior to graduation.

Admission to the Doctoral Program

Departmental admission to the doctoral program in materials science (as distinguished from admission to candidacy for the PhD program) requires a satisfactory score on the written and oral sections of the qualifying examination. (See "Examinations" section below.) A candidate has a maximum of two and a half years following entrance into the doctoral program to be admitted to candidacy. Contact the Toulouse School of Graduate Studies or the program for current admission requirements, or see information posted on the graduate school web site at *www.gradschool.unt.edu*.

Approximately a year after the candidate is admitted to candidacy, the student is examined on the chosen area of specialization: metallic, ceramic, polymer or electronic materials. (See "Examinations" section below for details.)

Enrollment in MTSE 6950 is not allowed until the student has been admitted to candidacy and has successfully passed the examination on the chosen specialization.

Examinations

1. A written qualifying examination is taken after completion of the core curriculum courses over the contents of these courses. This examination is generally conducted in the summer term/semester.

2. After passing the written exam, students are required to complete and defend an original proposal unrelated to their research.

3. Upon passing the written and oral examination by the examination committee, the applicant is admitted to candidacy.

4. A comprehensive oral exam related to the area of specialization of the student (metallic, ceramic, polymer or electronic materials), not to be confused with the student's PhD dissertation defense, is taken by doctoral candidates approximately one year after they have completed the qualifying and written exam.

5. Details of the examination schedule, expectations and criteria for successful completion are available in the Materials Science Graduate Student Handbook available in the department office and posted to the department web site.

Final Examination

This oral examination is primarily a defense of the dissertation, which must be submitted in final form to the final examination committee at least seven days prior to the scheduled oral examination.

Course Work

For the student who has a BS degree, the approximate requirements follow:

1. **Core Courses** (12 hours)

- MTSE 5000, Thermodynamics of Materials
- MTSE 5010, Bonding, Structure and Crystallography
- MTSE 5500, Electronic, Optical and Magnetic Materials
- MTSE 6100, Mechanical Properties of Materials

2. **Electives** (30 hours)

Thirty credit hours may be chosen from materials science or related fields, as approved by the major professor and the advisory committee.

3. **Individual Research** (26–34 hours)

- MTSE 6940, Individual Research

Additional course work may be taken in lieu of individual research hours.

4. **Seminar in Materials Science and Engineering** (2–10 hours)

- MTSE 5700, Seminar in Materials Science and Engineering

Please see "Seminar in Current Topics in Materials Science and Engineering".

5. **Dissertation** (12 hours minimum)

• MTSE 6950, Doctoral Dissertation

Seminar in Current Topics in Materials Science and Engineering

All doctoral students are expected to attend MTSE 5700 during each term/semester of full-time graduate study. A seminar based on the student's dissertation research must be given during the regularly scheduled class time prior to and in addition to the formal defense of the dissertation.

Minor in Materials Science and Engineering

Students pursuing degrees in other disciplines can apply for a minor in materials science through the department office. The minor of materials science requires 12 hours of materials science related course work approved by the department graduate advisor.

Courses of Instruction

All Courses of Instruction are located in one section at the back of this catalog.

Course and Subject Guide

The "Course and Subject Guide," found in the Courses of Instruction section of this book, serves as a table of contents and provides quick access to subject areas and prefixes.

Department of Mechanical and Energy Engineering

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Nourredine Boubekri, Interim Chair

Graduate Faculty: Boetcher, Choi, Feng, Prasad, Traum.

The Department of Mechanical and Energy Engineering at the University of North Texas is committed to academic excellence in graduate education and research in all areas pertinent to energy conservation and thermal engineering. The goals of the department and its faculty are (1) to provide high quality and innovative educational programs at the undergraduate and graduate levels; to foster lifelong learning; to promote professionalism and ethical standards; and to help students develop leadership qualities; (2) to pursue excellence in scholarly research in areas of mechanical and energy engineering; (3) to collaborate with engineers in industry, national laboratories and government agencies in the solution of national and global problems related to energy use and its environmental impacts.

Research

Research areas within the department include the following:

• **Advanced energy conversion** with applications to energy conversion, alternative energy sources, and energy conservation methods and systems.
• **Computational fluid dynamics (CFD) and computational heat transfer (CHT)** with applications to environmental effects of energy production, global environmental changes, buoyant flows, fluid distribution manifolds, biological flow and heat transfer, and thermal characteristics of electronic equipment.
• **Micro/nano-scale science and technology** with applications to femto-second laser machining, plasma dynamics, nano-scale fabrication, non-tube properties and the transport properties of micro- and non-particles.