Engineering, M.S. (Concentration in Materials and Manufacturing Technology)

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Materials and Manufacturing Technology (MMT) is concerned with the generation and application of knowledge relating the composition, structure, and processing of materials to their properties and applications, as well as the manufacturing technologies needed for production. During the past two decades, MMT has become an important component of modern engineering education, partly because of the increased level of sophistication required of engineering materials in a rapidly changing technological society, and partly because the selection of materials has increasingly become an integral part of almost every modern engineering design. In fact, further improvements in design are now viewed more and more as primarily materials and manufacturing issues. Both the development of new materials and the understanding of present-day materials demand a thorough knowledge of basic engineering and scientific principles including, for example, crystal structure, mechanics, mechanical behavior, electronic, optical and magnetic properties, thermodynamics, phase equilibria, heat transfer, diffusion, and the physics and chemistry of solids and chemical reactions.

The field of MMT ranks high on the list of top careers for scientists and engineers. The services of these engineers and scientists are required in a variety of engineering operations dealing, for example, with design of semiconductors and optoelectronic devices, development of new technologies based on composites and high-temperature materials, biomedical products, performance (quality, reliability, safety, energy efficiency) in automobile and aircraft components, improvement in nondestructive testing techniques, corrosion behavior in refineries, radiation damage in nuclear power plants, fabrication of steels, and construction of highways and bridges.

Subjects of interest in Materials and Manufacturing Technology cover a wide spectrum, ranging from metals, optical and electronic materials to superconductive materials, ceramics, advanced composites, and biomaterials. In addition, the emerging new research and technological areas in materials are in many cases interdisciplinary. Accordingly, the principal objective of the graduate curriculum is to integrate a student’s area of emphasis—whether it be chemical processing and production, electronic and photonic materials and devices, electronic manufacturing and packaging, or materials engineering—into the whole of materials and manufacturing technology. Such integration will increase familiarity with other disciplines and provide students with the breadth they need to face the challenges of current and future technology.

Students with a bachelor’s degree may pursue either the M.S. or Ph.D. in Engineering with a concentration in Materials and Manufacturing Technology (MMT). If students choose to enter the Ph.D. program directly, it is a requirement that they earn an M.S. along the way toward the completion of their Ph.D.

Given the nature of Materials and Manufacturing Technology as an interdisciplinary program, students having a background and suitable training in either Materials, Engineering (Biomedical, Civil, Chemical, Electrical, and Mechanical), or the Physical Sciences (Physics, Chemistry, Geology) are encouraged to participate. Recommended background courses include an introduction to materials, thermodynamics, mechanical properties, and electrical/optical/magnetic properties. A student with an insufficient background may be required to take remedial undergraduate courses following matriculation as a graduate student.

Core Requirements

Because of the interdepartmental nature of the concentration, it is important to establish a common foundation in Materials and Manufacturing Technology (MMT) for students from various backgrounds. This foundation is sufficiently covered in MMT courses that are listed below and that deal with the following topics: BME 262 Microimplants; MSE 200 Structure of Materials; ENGRMAE 252 Fundamentals of Microfabrication or ENGR 265 Advanced Manufacturing; ENGRMAE 259 Mechanical Behavior of Solids - Atomistic Theories. Core courses must be completed with a grade of B (3.0) or better.

Electives

Electives are grouped into four areas of emphasis.

Chemical Processing and Production:	
CHEM 213	Chemical Kinetics
CBE 200	Applied Engineering Mathematics I
CBE 210	Reaction Engineering
CBE 220A	Transport Phenomena I
CBE 240	Advanced Engineering Thermodynamics
ENGRCEE 262	Environmental Chemistry II
ENGRCEE 265	Physical-Chemical Treatment Processes

ENGRCEE 276	Hydrology
Electronic and Photonic Materials and Devices:	
BME 210	Molecular and Cellular Engineering
BME 251	Engineering Medical Optics
EECS 174	Semiconductor Devices
EECS 176	Fundamentals of Solid-State Electronics and Materials
EECS 188	Optical Electronics
EECS 277A	Advanced Semiconductor Devices I
EECS 277B	Advanced Semiconductor Devices II
EECS 277C	Nanotechnology
EECS 285A	Optical Communications
EECS 285B	Lasers and Photonics
EECS 280A	Advanced Engineering Electromagnetics I
EECS 280B	Advanced Engineering Electromagnetics II
ENGRMAE 220	Conduction Heat Transfer
ENGRMAE 221	Convective Heat and Mass Transfer
Biomedical and Electronic Manufacturing:	
BME 222	Biofluid Mechanics
BME 251	Engineering Medical Optics
EECS 279/ENGRMAE 249	Micro-Sensors and Actuators
ENGRMAE 212	Engineering Electrochemistry: Fundamentals and Applications
ENGRMAE 242	Robotics
ENGRMAE 247/EECS 278	Micro-System Design
ENGRMAE 250	Biorobotics
ENGRMAE 253	Advanced BIOMEMS Manufacturing Techniques
Materials Engineering:	
CHEM 225	Polymer Chemistry: Synthesis and Characterization of Polymers
MSE 241	Nano-Scale Materials and Applications
ENGRCEE 242	Advanced Strength of Materials
ENGRCEE 254	Advanced Reinforced Concrete Behavior and Design
ENGRCEE 255	Advanced Behavior and Design of Steel Structures
ENGRMAE 212	Engineering Electrochemistry: Fundamentals and Applications
ENGRMAE 224	Advanced Transport Phenomena
ENGRMAE 230A	Inviscid Incompressible Fluid Mechanics I
ENGRMAE 230B	Viscous Incompressible Fluid Mechanics II
ENGRMAE 230C	Compressible Fluid Dynamics
ENGRMAE 254	Mechanics of Solids and Structures
ENGRMAE 255	Composite Materials and Structures
ENGRMAE 258	Mechanical Behavior of Solids - Continuum Theories
MSE 205	Materials Physics
MSE 254	Polymer Science and Engineering
MSE 255A	Design with Ceramic Materials
MSE 256A	Mechanical Behavior of Engineering Materials
MSE 259	Transmission Electron Microscopy
MSE 264	Scanning Electron Microscopy
MSE 273	Electroceramics & Solid State Electrochemical Systems
PHYSICS 238A- 238B- 238C	Condensed Matter Physics and Condensed Matter Physics and Condensed Matter Physics

It should be noted that specific course requirements within the area of emphasis are decided based on consultation with the Director of the MMT concentration.

Two options are available for M.S. students: a thesis option and a comprehensive examination option. Both options require the completion of at least 12 courses of study.

Plan I. Thesis Option

For the thesis option, students are required to complete an original research project and write an M.S. thesis. A committee of three full-time faculty members is appointed to guide the development of the thesis. Students must also obtain approval for a complete program of study from the program director. At least seven courses (3-unit or 4-unit) must be taken from courses numbered 200–289, among which at least four courses (3-unit or 4-unit) are from MMT core courses and at least three courses (3-unit or 4-unit) are in the area of emphasis approved by the faculty advisor and the graduate advisor. Four units of BME 296, CBE 296, EECS 296, ENGRCEE 296, or ENGRMAE 296 count as the equivalence of one course. Up to three courses equivalent of BME 296, CBE 296, EECS 296, ENGRCEE 296, or ENGRMAE 296 and up to two courses (3-unit or 4-unit) of upper-division undergraduate elective courses taken as a graduate student at UCI can be applied toward the 12-course requirement.

Plan II. Comprehensive Examination Option

For the comprehensive examination option, students are required to complete minimally 12 courses (3-unit or 4-unit) of study. At least eight courses (3-unit or 4-unit) must be taken from courses numbered 200–289, among which at least four courses (3-unit or 4-unit) are from MMT core courses and at least four courses (3-unit or 4-unit) are in the area of emphasis approved by the faculty advisor and the graduate advisor. Four units of BME 299, CBE 299, EECS 299, ENGRCEE 299, or ENGRMAE 299 count as the equivalence of one course. One course equivalent of BME 299, CBE 299, EECS 299, ENGRCEE 299, or ENGRMAE 299 and up to two courses (3-unit or 4-unit) of upper-division undergraduate elective courses taken as a graduate student at UCI can be applied toward the 12-course requirement.

In the last quarter, an oral comprehensive examination on the contents of study will be given by a committee of three faculty members including the advisor and two members appointed by the program director. Part-time study for the M.S. is available and encouraged for engineers working in local industries. Registration for part-time study must be approved in advance by the MMT program director, the School’s Associate Dean, and the Graduate Dean.

In addition to fulfilling the course requirements outlined above, it is a University requirement for the Master of Science degree that students fulfill a minimum of 36 units of study.

Ozdal Boyraz (silicon photonics, nonlinear optics in silicon, cascaded cavity silicon Raman laser)

Peter J. Burke (nano-electronics, bio-technology)

Penghui Cao (fundamental understanding of the mechanisms by which materials plasticly deform adn fail, particularly in extreme environments)

Camilo Velez Cuervo [micro/nano robotics, micro/nano device fabrication, microfabrication of magnetic microsystems, magnetic micro/nanostructures, selective magnetization of micro patterns, microsystems (MEMS), biomedical microsystems, semiconductor devices and microfluidics]

Zhongping Chen (biomedical optics, optical coherence tomography, bioMEMS, and biomedical devices)

James C. Earthman (biomaterials, dental and orthopedic implants, green materials, nanocrystalline alloys, deformation and damage processes)

Rahim Esfandyarpour (nanotechnology and nanoscience, flexible electronics, MEMS and NEMS fabrication and modeling, stretchable and wearable bio devices, translational micro/nanotechnologies, biological and chemical sensors, microfluidics, microelectronics circuits and systems, physiological monitoring, Internet of Things(IOT) bio devices, technology development for personalized/precision medicine, and Point of Care(POC) diagnostics)

Franco De Flaviis (microwave systems, wireless communications, electromagnetic circuit simulations)

Manuel Gamero-Castaño (electric propulsion, with emphasis on colloid thruster technology for precision formation flying missions and Hall thrusters, electrohydrodynamic atomization of liquids and related problems like electrospray ionization and technological applications of electrosprays, aerosol diagnostics)

Alon A. Gorodetsky (cephalopods, adaptive materials, camouflage, bioelectronics)

Michelle Khine (development of novel nano- and micro-fabrication technologies and systems for single cell analysis, stem cell research, in vitro diagnostics)

David Kisailus (investigation of synthesis – structure and structure - property relationships in biological and biomimetic materials, development of multifunctional structural materials, synthesis and crystal growth of nanoscale materials for energy conversion, storage and environmental remediation)

Lawrence Kulinsky (micro- and nano-manufacturing, hybrid manufacturing, microfluidics, electrokinetic phenomena, BioMEs, personalized diagnostics, and drug delivery)

John C. LaRue (fluid mechanics, micro-electrical-mechanical systems (MEMS), turbulence, heat transfer, instrumentation)

Abraham Lee (Lab-on-a-Chip health monitoring instruments, drug delivery micro/nanoparticles, integrated cell sorting microdevices, lipid vesicles as carriers for cells and biomolecules, high throughput droplet bioassays, microfluidic tactile sensors)

Chin C. Lee (bonding technology, electronic packaging, acoustics, microwaves, semiconductor devices, thermal management)

Henry P. Lee (photonics, fiber-optics and compound semiconductorsphotonics, fiber-optics and compound semiconductors)

Jaeho Lee (Nanoscale heat transfer and materials engineering, targeting impact on semiconductor devices and energy conversion systems via metrology development)

Guann Pyng Li (high-speed semiconductor technology, optoelectronic devices, integrated circuit fabrication and testing)

Marc J. Madou (fundamental aspects of micro/nano-electro-mechanical systems [MEMS/NEMS], biosensors, nanofluidics, biomimetics)

Michael McCarthy (machine design and kinematic synthesis of spatial mechanisms and robots)

Farghalli A. Mohamed (mechanical behavior of engineering materials such as metals, composites and ceramics, the correlation between behavior and microstructure, creep, and superplasticity, mechanisms responsible for strengthening and fracture)

Ayman S. Mosallam (advanced composites and hybrid systems, seismic repair and rehabilitation of structures, blast mitigation and diagnostic/prognostic techniques for infrastructure security)

Daniel R. Mumm (development of materials for power generation systems, propulsion, integrated sensing advanced vehicle concepts and platform protection)

Xiaoqing Pan (atomic-scale structure, properties and dynamic behaviors of advanced materials including thin films and nanostructures for memories, catalysts, and energy conversion and storage devices)

Regina Ragan (exploration and development of novel materials systems for nanoscale electronic and optoelectronic devices)

Timothy J. Rupert (mechanical behavior, nanomaterials, structure-property relationships, microstructural stability, grain boundaries and interfaces, materials characterization)

Frank G. Shi (optoelectronic devices and materials, optoelectronic device packaging materials, optoelectronic medical devices and packaging, white LED technologies, high power LED packaging)

Andrei M. Shkel (design and advanced control of micro-electro-mechanical systems (MEMS), precision micro-sensors and actuators for telecommunication and information technologies, MEMS-based health monitoring systems, disposable diagnostic devices, prosthetic implants)

Lizhi Sun (CEE) (micro- and nano-mechanics, composites and nanocomposites, smart materials and structures, multiscale modeling, elastography)

William Tang (micro-electro-mechanical systems (MEMS) nanoscale engineering for biomedical applications, microsystems integration, microimplants, microbiomechanics, microfluidics)

Chen S. Tsai (integrated and fiber optics, devices and materials, integrated acoustooptics and magnetooptics, integrated microwave magnetics, Ultrasonic Atomization for Nanoparticles Synthesis, silicon photonics)

Lorenzo Valdevit, Director (multifunctional sandwich structures, thermal protection systems, morphing structures, active materials, MEMS, electronic packaging, cell mechanic)

Yoon Jin Won (multi-scale structures for thermal and energy applications, in particular fabrication, characterization, and integration of structured materials)

Albert Yee (nanofabrication of soft materials, physics of polymer thin films, nanomechanical properties of polymers, ultra-low-k dielectrics, fracture and toughening of polymer nanocomposites)