Materials and Nanotechnology

Department Information

- **Program Director:**
  Erik K. Hobbie, Ph.D.
- **Email:**
  Erik.Hobbie@ndsu.edu
- **Department Phone:**
  (701) 231-6103
- **Department Web Site:**
  www.ndsu.edu/materials_nanotechnology/
- **Application Deadline:**
  April 1 for fall semester.
- **Credential Offered:**
  Ph.D., M.S.
- **Test Requirement:**
  GRE
- **English Proficiency Requirements:**
  TOEFL iBT 71, IELTS 6

Program Description

North Dakota State University offers an interdisciplinary program leading to the Master of Science or Ph.D. degree in Materials and Nanotechnology (MNT). The program includes a series of required MNT core courses; additional elective courses; written and oral preliminary examinations; a doctoral dissertation based on independent, original research in the area of materials and nanotechnology; and a final oral examination of the dissertation.

The program in Nanotechnology and Nanomaterials is open to qualified graduates of universities and colleges of recognized standing. Students with a degree in the disciplines of chemistry, engineering, material science and engineering, physics, polymer science, polymer engineering, or related fields will be considered for admission. Applicants must meet the Graduate School requirements.

Financial Assistance

Students are routinely supported through research assistantships. Applicants are considered on the basis of scholarship, potential to undertake advanced study and research, and financial need. All students who submit complete applications by the appropriate deadlines are considered for assistantships. Exceptional students are also eligible for university fellowships that are awarded on a competitive basis.

By the end of the first academic year, the student will select an academic adviser from among the MNT faculty and arrange for the appointment of a Graduate Advisory Committee. This committee will consist of at least four members of the graduate faculty. This includes the student's major adviser, at least one additional MNT faculty member, and an appointee of the Graduate School.

The plan of study will be prepared by the student, in consultation with the major adviser, by the end of the first year in residence. The plan shall be approved by the student's Graduate Supervisory Committee, the MNT Program Director, and the Graduate School dean. The plan of study must be filed in the Graduate School prior to scheduling the comprehensive written examination.

Master of Science

Materials & Nanotechnology students are able pursue a master's degree under either the Plan A - Master's Thesis or the Plan C - Culminating Experience option. Each option requires a minimum of 30 graduate credits with a cumulative grade point average of 3.0 or better.

The Plan A thesis option represents a more traditional Master of Science degree, with an independent research component in the form of an original thesis that can serve as a foundation for future doctoral work in science or engineering. For the Thesis Option, of the required minimum 30 graduate credits, at least 16 credits must be from approved graduate courses numbered from 601-689, 691, 700-789, and 791 while the research credits (798) must be not fewer than 6 nor more than 10.

The Plan C option is appropriate for working professional students or students who are certain that they do not wish to pursue future graduate work in any field of science or engineering to the level of doctorate. In the context of the MNT program, this option requires a 6-10 credit culminating experience (794) which replaces the research credits (798).
Ph.D.

The Graduate School requires the plan of study for the Ph.D. degree to include not less than 90 semester graduate credits. Of this total, not less than 27 credits must be in courses other than seminar or research credits. Of the 27 course credits, 15 must be at the 700-789 level. The MNT Ph.D. program requires students to complete a series of 7 core courses totaling 17 semester credits. The student will complete additional elective courses to fulfill the Graduate School requirement of 27 semester credits in academic courses. An overall GPA of 3.0 or better must be maintained.

### Core Curriculum

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MNT 729</td>
<td>Materials Characterization</td>
<td>3</td>
</tr>
<tr>
<td>MNT 730</td>
<td>Nanotechnology and Nanomaterials</td>
<td>3</td>
</tr>
<tr>
<td>MNT 732</td>
<td>Physical Properties of Materials</td>
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<tr>
<td>MNT 745</td>
<td>Preparing Future Researchers</td>
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<td>MNT 756</td>
<td>Molecular Modeling</td>
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<td>MNT 760</td>
<td>Materials Synthesis Processing</td>
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<tr>
<td>MNT 790</td>
<td>Graduate Seminar</td>
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</tbody>
</table>

Students must complete at least an additional 12 credits of graduate level coursework. The courses should be chosen by the students in consultation and with the approval of the student's committee.

Suggested courses include the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Microelectronics Focus</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABEN 682</td>
<td>Instrumentation &amp; Measurements</td>
<td>3</td>
</tr>
<tr>
<td>CPM 796</td>
<td>Special Topics</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 766</td>
<td>Quantum Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 767</td>
<td>Quantum Chemistry II</td>
<td>2</td>
</tr>
<tr>
<td>ENGR 780</td>
<td>Electromagnetic Theory</td>
<td>3</td>
</tr>
<tr>
<td>ECE 751</td>
<td>Electromagnetic Theory and Applications</td>
<td>3</td>
</tr>
<tr>
<td>IME 627</td>
<td>Packaging for Electronics</td>
<td>3</td>
</tr>
<tr>
<td>IME 720</td>
<td>Surface Engineering</td>
<td>3</td>
</tr>
<tr>
<td>IME 635</td>
<td>Plastics and Injection Molding Manufacturing</td>
<td>3</td>
</tr>
<tr>
<td>MNT 735</td>
<td>Optoelectronics Materials and Processing</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 771</td>
<td>Quantum Physics I</td>
<td>3</td>
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<tr>
<td><strong>Biomaterials Focus</strong></td>
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<tr>
<td>ABEN 758</td>
<td>Applied Computer Imaging and Sensing for Biosystems</td>
<td>3</td>
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<tr>
<td>BIOC 716</td>
<td>Protein and Enzyme Biochemistry</td>
<td>3</td>
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<tr>
<td>BIOC 673</td>
<td>Methods of Biochemical Research</td>
<td>3</td>
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<tr>
<td>CE 725</td>
<td>Biomaterials-Materials in Biomedical Engineering</td>
<td>3</td>
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<tr>
<td>CPM 771</td>
<td>Modern Methods of Polymer Characterization</td>
<td>3</td>
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<tr>
<td>ME 668</td>
<td>Introduction to Biomechanics</td>
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<tr>
<td>ME 731</td>
<td>Mechanical Behavior of Materials</td>
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<tr>
<td>ME 743</td>
<td>Biomechanics Of Impact</td>
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<td>ECE 685</td>
<td>Biomedical Engineering</td>
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<tr>
<td>ECE 687</td>
<td>Cardiovascular Engineering</td>
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<tr>
<td>PSCI 611</td>
<td>Principles of Pharmacokinetics and Pharmacodynamics</td>
<td>3</td>
</tr>
<tr>
<td>PSCI 701</td>
<td>Quantitative Drug Design</td>
<td>2</td>
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<tr>
<td><strong>Nanomaterials Focus</strong></td>
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<tr>
<td>CE 641</td>
<td>Finite Element Analysis</td>
<td>3</td>
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<tr>
<td>CE 793</td>
<td>Individual Study/Tutorial</td>
<td>3</td>
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<tr>
<td>CPM 673</td>
<td>Polymer Synthesis</td>
<td>3</td>
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<tr>
<td>CHEM 766</td>
<td>Quantum Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 767</td>
<td>Quantum Chemistry II</td>
<td>2</td>
</tr>
<tr>
<td>CPM 686</td>
<td>Corrosion and Materials</td>
<td>3</td>
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</tbody>
</table>
CPM 773  Organic Chemistry Of Coatings 3
CPM 782  Physical Chemistry Of Coatings 3
CPM 796  Special Topics 3
IME 720  Surface Engineering 3
ME 682  Fuel Cell Science and Engineering 3
ME 712  Advanced Finite Element Analysis 3
ME 733  Polymer Nanocomposites 3
ME 734  Smart Materials and Structures 3
PHYS 758  Statistical Physics 3
PHYS 781  Solid State Physics 3

**General Materials Science and Engineering Focus**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ABEN 658</td>
<td>Process Engineering for Food, Biofuels and Bioproducts</td>
<td>3</td>
</tr>
<tr>
<td>ABEN 644</td>
<td>Transport Processes</td>
<td>3</td>
</tr>
<tr>
<td>ME 673</td>
<td>Polymer Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CE 641</td>
<td>Finite Element Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CE 720</td>
<td>Continuum Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 732</td>
<td>Advanced Survey of Analytical Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 736</td>
<td>Mass Spectrometry</td>
<td>2</td>
</tr>
<tr>
<td>CPM 673</td>
<td>Polymer Synthesis</td>
<td>3</td>
</tr>
<tr>
<td>ME 633</td>
<td>Composite Materials Science and Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ME 751</td>
<td>Advanced Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 611</td>
<td>Optics for Scientists &amp; Engineers</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 781</td>
<td>Solid State Physics</td>
<td>3</td>
</tr>
</tbody>
</table>

**Affiliated Faculty**

**Iskander Akhatov, Ph.D.**  
Lomonosov University of Moscow, 1983  
Research Interests: Fluid Dynamics, Multiphase Systems, Heat and Mass Transfer

**Dilpreet Bajwa, Ph.D.**  
University of Illinois, 2000  
Research Interests: Biobased Polymer Composites, Wood Composites, Processing and Characterization, Recycled Materials Utilization, Durability Engineering via Weathering and Degradation Mechanisms

**Achintya N. Bezbaruah, Ph.D.**  
University of Nebraska-Lincoln, 2002  
Research Interests: Environmental sensors, Recalcitrant and micro pollutants, Contaminant fate and transport, Small community water and wastewater treatment, Environmental management

**Gordon P. Bierwagen, Ph.D.**  
Iowa State University, 1968  
Research Interests: Surface chemistry of coatings materials, corrosion, electrochemistry of coatings, coating lifetime prediction, concentrated random composites

**Bret Chisholm, Ph.D.**  
University of Southern Mississippi, 1993  
Research Interests: Combinatorial chemistry methods for coatings, novel organic-inorganic coatings applications, new polyester nanocomposites

**Dr. Yongki Choi, PhD**  
City University of New York, 2010  
Research Interests: Nanoparticle based electronics and sensors.

**Andrew Croll, Ph.D.**  
McMaster University, Ontario, 2009  
Research Interests: Polymers, Diblock Copolymers, Thin Films, Pattern Formation, Mechanics

**Stuart G. Croll, Ph.D.**  
University of Leeds, 1974  
Postdoctoral: National Research Council, Canada
Research Interests: Weathering durability of coatings, physical chemistry and suspension stability, pigment-polymer interactions, film formation processes, coating and polymer physics

Alan R. Denton, Ph.D.
Cornell University, 1991
Postdoctoral, University of Guelph, 1991-94; Technical University of Vienna, 1994-95, Research Center Julich, 1996-98
Research Interests: Soft Condensed Matter Theory, Computational Physics

Daniel L. Ewert, Ph.D.
University of North Dakota, 1989
Research Interests: Biomedical Engineering

Thomas Ihle, Ph.D.
Technical University, 1996
Research Interests: Theory and Simulation of Complex Fluids (Colloids, microemulsions and Biopolymers)

Long Jiang, Ph.D.
Nanyang Technological University, 2003
Research Interests: Polymer and Polymer Composite Processing, Polymer Processing Machinery and Design, Nanocomposites, Polymers and Composites Derived from Biomass, Functional Composites with Novel Microstructures

Alan R. Kallmeyer, Ph.D.
University of Iowa, 1995
Research Interests: Theoretical, Computational, and Experimental Solid Mechanics, Fatigue and Fracture of Engineering Materials, Composite Materials

Dinesh Katti, Ph.D.
University of Arizona, 1991
Research Interests: Geotechnical Engineering, Constitutive Modeling of Geologic Materials, Expansive Soils, Multiscale Modeling, Steered Molecular Dynamics, Computational Mechanics, Nanocomposite, and Bionanocomposites. Computational Biophysics

Kalpana Katti, Ph.D.
University of Washington, 1996
Research Interests: Advanced Composites, Nanomaterials, Biomaterials, Biomimetics, Materials Characterization and Modeling, Analytical Electron Microscopy, and Microspectroscopy, Bone Tissue engineering

Svetlana Kilina, Ph.D.
University of Washington, Seattle, 2007

Ivan T. Lima Jr., Ph.D.
University of Maryland, 2003
Research Interests: Photonics

Valery R. Marinov, Ph.D.
Technical University of Sofia, 1992
Research Interests: Process Modeling for Machining, Theory of Metal Cutting, Tribological Coatings, Including Nanocomposite Coatings and Deposition Methods, Design for Composites Manufacturing Processes, Packaging for low-cost disposable microelectronics, Direct-write material deposition methods, Laser processing

Sylvio May, Ph.D.
Jena, 1996
Research Interests: Physics of Lipid Membranes, Biophysics

Seth C. Rasmussen, Ph.D.
Clemson University, 1994
Postdoctoral, University of Oregon, 1995-99
Research Area: Inorganic/Organic Materials Chemistry, Chemical History

Jing Shi, Ph.D.,
Purdue University, 2004
Research Interests: Microelectronics

Wenfang Sung, Ph.D.
Chinese Academy of Sciences, 1995;
Postdoctoral, University of Alabama, Birmingham, 1997-1999
Research Area: Organic Materials Chemistry

Chad A. Ulven, Ph.D.
University of Alabama at Birmingham, 2005

Alexander J. Wagner, Ph.D.
University of Oxford, 1997
Research Interests: Computational Soft Matter, Phase Separation, Diffusion, Interfaces Physics

Xinnan Wang, Ph.D.
University of South Carolina, 2008
Research Interests: Experimental Biomechanics, Synthesis of Nanomaterials, Nanomechanical Characterization, Nanomanipulation

Dean Webster, Ph.D.
Virginia Polytechnic Institute and State University 1984
Research Interests: Synthesis of high performance polymers, polymerization reactions, crosslinking chemistry, and quantitative structure-property relationship

Xiangfa Wu, Ph.D.
University of Nebraska-Lincoln, 2003
Beijing Institute of Technology, 1998
Research Interests: Nanofabrication and Nanomaterials, Advanced Composites, Fracture and Impact Mechanics