Materials Science and Engineering, Ph.D.

Meeting many of the most critical challenges facing modern society requires advances in the materials that underpin new technologies. Examples include providing carbon-free and renewable energy, clean water, advanced medical treatments and devices, and sustainable materials manufacturing. New materials are also required for continued economic growth in areas as diverse as aerospace, computing, and sensors.

Materials scientists and engineers at UW–Madison work toward solutions to these problems via research in a wide variety of areas. Research areas include ceramics, computational material science; composites; corrosion; electrical, optical, magnetic materials; growth and synthesis; joining; materials for energy; metals; materials characterization and microscopy; nanomaterials; phase transformations; photonics; polymers and biomaterials; materials for nuclear energy; quantum computing; self-assembly; structural materials and mechanical properties; surfaces and interfaces; sustainability; thin films; and wear.

More broadly, the field of materials science and engineering is in the middle of a revolution in how we design and deploy new materials. The old way is by trial and error, which involves laboratory testing of hundreds or thousands of candidate materials, which is costly and can take decades to develop a new materials and deploy it in practical technologies. The emerging new method leverages advances in computational materials science; materials databases, data science, and machine learning; and high throughput materials synthesis and characterization to achieve true design of materials. The goal is to develop and deploy new materials much more quickly and much lower cost than ever before. Materials design is a major theme of materials research on campus, organized around the areas of materials design via atomically controlled thin film systems, modular design of nanomaterials, and integrated experimental and computational materials engineering. Materials design and these themes cut across the research and application areas list above.

Materials research extends across campus, well beyond the boundaries of the Department of Materials Science and Engineering, so graduate students in materials can pursue research with a large number of affiliate faculty. Faculty emphasize the cross-cutting, interdisciplinary nature of materials research, which is also reflected by the diverse undergraduate backgrounds of the student body, many of whom do not have undergraduate degrees in materials.

Materials research benefits from major campus facilities, including the Materials Science Center, the Wisconsin Microscopy and Characterization Center, Wisconsin Center for Applied Microelectronics, and the Soft Materials Laboratory. Research is supported by major centers, including the National Science Foundation Materials Research Science and Engineering Center and the Grainger Institute for Engineering.

Materials graduates from Wisconsin find long-term success in careers in private industry, national laboratories, and academia in the US and around the world.

Funding

The vast majority of students receive funding in the form of fellowships, research assistantships, or advanced opportunity grants. A limited number of teaching assistantships are available.

Requirements

Minimum Degree Requirements and Satisfactory Progress

To make progress toward a graduate degree, students must meet the Graduate School Minimum Degree Requirements and Satisfactory Progress (http://guide.wisc.edu/graduate/#policiesandrequirementstext) in addition to the requirements of the program.

Doctoral Degrees

Ph.D.

Minimum Graduate Degree Credit Requirement

51 credits

Minimum Graduate Residence Credit Requirement

32 credits

Minimum Graduate Coursework (50%) Requirement

At least 50% of credits applied towards the graduate degree requirement must be with graduate-level coursework; courses with the Graduate Level Coursework attribute are identified and searchable in the university’s Course Guide (http://my.wisc.edu/CourseGuideRedirect/BrowseByTitle).

Prior Coursework Requirements: Graduate Work from Other Institutions

With program approval, students are allowed to count graduate coursework from other institutions toward the minimum graduate degree credit requirement and the minimum graduate coursework (50%) requirement. No credits from other institutions can be counted toward the minimum graduate residence credit requirement. For additional requirements, consult the program.

Prior Coursework Requirements: UW–Madison Undergraduate

With program approval, students are allowed to count up to 7 credits numbered 300 or above toward the minimum graduate degree credit requirement when taken in excess of the undergraduate degree requirements; if that coursework is numbered 700 or above it may be used to satisfy the minimum graduate coursework (50%) requirement. No credits can be counted toward the minimum graduate residence credit requirement.

Prior Coursework Requirements: UW–Madison University Special

Typically, no UW-Madison University Special student credits may be counted toward graduate program requirements. However, with program approval, students are allowed to count up to 15 credits of coursework numbered 300 or above taken as a UW–Madison Special student toward...
the minimum graduate residence credit requirement, and the minimum graduate degree credit requirement; if that coursework is numbered 700 or above it may satisfy the minimum graduate coursework (50%) requirement.

**CREDITS PER TERM ALLOWED**

15 credits

**PROGRAM-SPECIFIC COURSES REQUIRED**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>M S &amp; E 900</td>
<td>Materials Research Seminar ¹</td>
<td>1</td>
</tr>
<tr>
<td>M S &amp; E 530</td>
<td>Thermodynamics of Solids</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 551</td>
<td>Structure of Materials</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 521</td>
<td>Advanced Polymeric Materials</td>
<td>3</td>
</tr>
<tr>
<td>E P/E M A 547</td>
<td>Engineering Analysis I</td>
<td>3</td>
</tr>
<tr>
<td>CBE 660</td>
<td>Intermediate Problems in Chemical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>MATH 703</td>
<td>Methods of Applied Mathematics 1</td>
<td>3</td>
</tr>
<tr>
<td>MATH 704</td>
<td>Methods of Applied Mathematics-2</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 721</td>
<td>Theoretical Physics-Electrodynamics</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 752</td>
<td>Advanced Materials Science: Phase Transformations</td>
<td>3</td>
</tr>
</tbody>
</table>

Select two materials electives ²

¹ Take two semesters.
² Electives must be selected from a list available from the program.

**DOCTORAL MINOR/BREADTH REQUIREMENTS**

Doctoral students must complete a doctoral minor.

**OVERALL GRADUATE GPA REQUIREMENT**

3.00

**OTHER GRADE REQUIREMENTS**

The Graduate School requires an average grade of B or better in all coursework (300 or above, not including research credits) taken as a graduate student unless conditions for probationary status require higher grades. Grades of Incomplete are considered to be unsatisfactory if they are not removed during the next enrolled semester.

**PROBATION POLICY**

The Graduate School regularly reviews the record of any student who earned grades of BC, C, D, F, or Incomplete in a graduate course (300 or above), or grade of U in research credits. This review could result in academic probation with a hold on future enrollment or in being suspended from the Graduate School.

**ADVISOR**

Every graduate student is required to have an advisor. An advisor is a faculty member, or sometimes a committee, from the major department responsible for providing advice regarding graduate studies. An advisor generally serves as the thesis advisor. In many cases, an advisor is assigned to incoming students. To ensure that students are making satisfactory progress toward a degree, the Graduate School expects them to meet with their advisor on a regular basis.

Students without a researcher advisor at the end of their first year enrolled are in danger of failing to make adequate progress towards their degree. Students can be suspended from the Graduate School if they do not have an advisor.

**ASSESSMENT AND EXAMINATIONS**

1. Students must pass a qualifying exam in Materials Science and Engineering. The exam must be attempted within 13 months of the start of the student’s first semester enrolled. If the first attempt is not passed, a second attempt is required within four months.

2. Students must pass a preliminary exam/thesis proposal exam. This exam is typically undertaken by the end of the fourth semester enrolled and must be undertaken by the end of the fifth semester. If the first attempt is not passed, a second attempt is required within three months.

3. Students must prepare a doctoral dissertation, present it in a public seminar, defend it in closed examination by their doctoral committee, and deposit it with the Graduate School.

**TIME CONSTRAINTS**

The Ph.D. is typically completed within six years. A candidate for a doctoral degree who fails to take the final oral examination and deposit the dissertation within five years after passing the preliminary examination may be required to take another preliminary examination and to be admitted to candidacy a second time.

Doctoral degree students who have been absent for ten or more consecutive years lose all credits that they have earned before their absence. Individual programs may count the coursework students completed prior to their absence for meeting program requirements; that coursework may not count toward Graduate School credit requirements.

**LANGUAGE REQUIREMENTS**

None.

**ADMISSIONS**

Admission to the graduate program in the Department of Materials Science and Engineering is based on the student’s previous academic record, Graduate Record Exam (GRE) scores, letters of recommendation, TOEFL scores for non-native English speakers, and a personal statement. Students with undergraduate degrees in science or engineering outside materials science and engineering are routinely admitted. Admission is competitive.

**LEARNING OUTCOMES**

**KNOWLEDGE AND SKILLS**

- demonstrate an ability to synthesize knowledge from a subset of the biological, physical, and social sciences to help frame problems critical to the future of their discipline.
- conduct original research.
- demonstrate an ability to create new knowledge and communicate it to their peers.

**PROFESSIONAL CONDUCT**

- fosters ethical and professional conduct.
Faculty: Professors: Babcock, Eom, Evans, Gopalan, Kou, Lagally, Lakes, Morgan, Perepezko, Robertson, Stone, Szlufarska, Voyles; Associate Professors: Arnold, Wang; Assistant Professors: Kawasaki.

Affiliate Faculty: Abbott, Allen, Andrew, Ashton, Beebe, Booske, Botez, Cai, Chesler, Coppersmith, Cramer, Crone, Drugan, Eriksson, Eriten, Goldsmith, Gong, Gunasekaran, Hamers, Hitchon, Jiang, Jin, Kats, Keely, Klingenberg, Knevic, Kuech, Kulcinski, Li, Lynn, Ma, Masters, Mawst, McDermott, Murphy, Negrut, Ogle, Onellion, Osowald, Palecek, Pfefferkorn, Ploeg, Reed, Root, Rowlands, Rzchowski, Sarmadi, Shohet, Sridharan, Thelen, Turng, van der Weide, Vanderby, Weibel, Wendt, Williams, Winokur, Xu, Yu