

8 April 2021

TO: Faculty Senate

FROM: Paul Loikith, Chair, Graduate Council

RE: Graduate Certificate in Semiconductor Materials & Manufacturing

The following proposal has been approved by the Graduate Council and is recommended for approval by the Faculty Senate.

You may read the full text of the program proposal, as well as Faculty Budget Committee comments, at the [Online Curriculum Management System \(OCMS\) Curriculum Dashboard](#).

PROPOSAL SUMMARY FOR

Maseeh College of Engineering and Computer Science

Graduate Certificate in Semiconductor Materials & Manufacturing

Certificate Type

Graduate Certificate: Admission to graduate status required

Effective Term: Fall 2021

Overview of the Program

Semiconductors are materials whose electrical conductivities fall between those of conductors and insulators. They are crystalline or amorphous solids with distinct electrical characteristics. By varying their process conditions, like temperature and presence of impurities, their conductivities can be modified accordingly. Today, almost every electronic technology used in computers, cell phones and other electronic devices uses semiconductor materials—with the most important being the integrated circuit (IC). Other applications include amplification, switching, sensing, and energy conversion. PSU is situated at the center of the Silicon Forest, which is home to many local high-tech companies including Intel, Solar World, Mentor Graphics, Microchips, and Lam Research, to mention just a few. Certified graduate-level specialty training is highly desirable among the employees in these local companies. Employers offer incentives for employees to get advanced training to meet the challenges of new technological developments. Our graduate certificate program is designed to provide students with advanced training in semiconductor materials and manufacturing technologies.

The Semiconductor Materials and Manufacturing Certificate program equips students with the fundamental knowledge and technical skills needed to understand: 1) how semiconductor materials are made; 2) how their properties are characterized; 3) how the materials' failures are identified and analyzed; and 4) how the correlations between the processing conditions and the material properties are established. The curriculum for this program is strategically designed. Graduate-level courses in semiconductor materials, manufacturing processes, materials characterization and failure analysis techniques are bundled together as part of this program. Several courses contain lab sessions to enhance students' hands-on experiences. Although most of the courses for this program are offered

in-person at this time, an online offering for some of the courses in the near future is under consideration, especially for those courses that do not include lab sessions.

Evidence of Need

In 2018 there were ~200k employees in semiconductor manufacturing in Oregon and the semiconductor manufacturing sector growth exceeded 20% (highest growth of all manufacturing sectors). Comments and feedback from our former and current graduate students who are working full time in local semiconductor companies have suggested the critical need for this certificate program. It is expected that a significant number of employees from local companies would enroll in this program as companies actually provide employment incentives (pay tuitions and reimburse the book costs) to encourage their workers to “re-tool” and upskill themselves. Current graduate enrollments in ME 510 (new course proposal ME 577) Introduction to Semiconductor Manufacturing has averaged ~38 students per year. This exceeds initial expectations for graduate enrollment in the ME 477/577 course. These students are primarily full-time employees from local industry as employers encourage continuing education and these employees benefit financially with job advancement by obtaining certificates and advanced degrees.

Course of Study

The Semiconductor Materials and Manufacturing Graduate Certificate is a 16-credit program. Students are required to take **ME 577 Introduction to Semiconductor Manufacturing (4 credits)** and a minimum of 3 additional courses from the list below to earn the certificate.

Course number	Course Name	Credits
ME 513	Engineering Materials Science	4 Credits
ME 527	Phase Transformations and Kinetics in Materials	4 Credits
ME 528	Scanning Electron Microscopy for Materials and Device Characterization	4 Credits
ME 529	Transmission Electron Microscopy and Chemical Analysis of Materials	4 Credits
MSE 547	Diffusion	4 Credits
ME 547	Transfer and Rate Processes	4 Credits
ME 576	Materials Failure Analysis	4 Credits
ME 578	Introduction to Electronic Packaging	4 Credits

Minimum credits: 16