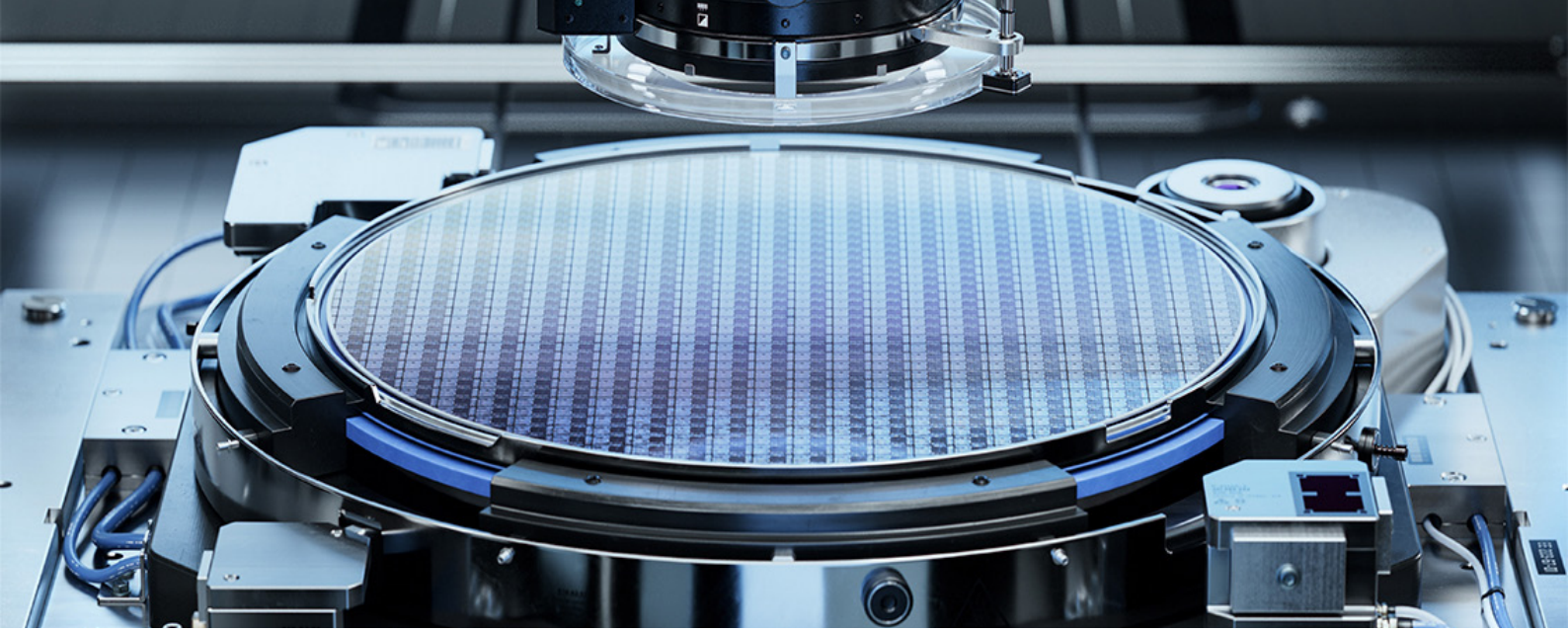

TECHNOLOGY OF EXTREME ULTRAVIOLET RADIATION

While not much time has passed since extreme ultraviolet radiation (EUV) might have been the most unknown range on the electromagnetic spectrum, it rapidly became the most important enabler for the future of computing devices, starting with the smartphone, tablet, or laptop you currently use to read this text.

ABOUT THIS COURSE

In this course you will get to know EUV and its role in the semiconductor industry where EUV lithography is used to produce the smallest and most complex nanostructures used as integrated circuits. You will learn about the technological challenges that entailed the introduction of EUV into its current industrial application, from the search for a proper radiation source, the complexity of optical systems, and the necessity to put the whole system into vacuum tight chambers. Get fascinated by the sheer power of interdisciplinary research that allowed EUV technology to become one of the most important technologies of the 21st century and become part of our journey to push the limits of nanostructuring as well as nanometrology.

PREREQUISITES

You should have the basic knowledge of mathematics and physics that are part of any mechanical or electrical engineering bachelor's degree or (applied) physics bachelor's degree, including basic knowledge of linear algebra and vector calculus.

WHAT YOU WILL LEARN

- Working principle, components, and technological challenges of industrial EUV technology - Principle and technologies of EUV radiation generationUnconstrained optimization
- Basic principles of light propagation and optics
- Types and applications of EUV optical components
- Concept and technology of photolithography
- Concept and technology of EUV metrology

INSTRUCTOR

Prof. Dr. Carlo Holly is professor of Optical Technologies at the RWTH Aachen University. He and his chair, the chair for Technology of Optical Systems TOS, work in close collaboration with the Fraunhofer-Institute for Laser Technology ILT in Aachen, where he is also head of the department Data Science and Measurement Technology. His areas of research include optical systems, computational optics, EUV technology, and digital photonic production. Prof. Holly received a diploma in mechanical engineering, a B. Sc. in physics, and a M. Sc. in theoretical particle physics, as well as a Ph.D. degree (Dr. rer. nat.) from RWTH Aachen University. In 2017 he joined TRUMPF Photonics in Princeton, USA, where he worked on the development of high-power semiconductor lasers. In 2020, as Head of R&D Photonics he worked on optical systems and photonics integration for non-invasive glucose measurement devices at DiaMonTech AG in Berlin. In 2021, Prof. Holly became full-time professor at the RWTH Aachen University. Since 2023, he is Fellow of the Max-Planck School of Photonics.

TIME COMMITMENT

The course is designed for 6 weeks. The expected time to complete each week is about 4-6 hours. This includes watching the lecture videos and answering the recap questions and doing the assignments.

COURSE OUTLINE

09 Oct. 2024

Week 1 | Fundamentals of EUV technology

You'll learn about Moore's law and how it pushed the semiconductor industry to select EUV lithography for the fabrication of integrated circuits with nanoscale features. To understand the need for EUV and its basic properties you'll be also given a comprehensive introduction to the basics of optics with regards to diffraction and the definition of Abbe's diffraction limit.

16 Oct. 2024

Week 2 | Generation of EUV radiation

The fundamentals and technologies you'll need to create artificial EUV radiation will be introduced to you in this week's lectures. The basic generation principles of radiation will be explained as well as the typical parameters a radiation source is judged by e.g., when considering an application in EUV lithography. The basic source types capable to create EUV radiation will be explained including a discussion on their advantages for different applications.

23 Oct. 2024

Week 3 | EUV optics I

EUV radiation cannot be manipulated with basic refractive lenses, so advanced tricks and technologies are developed to create optical components and illumination systems used in lithographic scanners or EUV metrology systems. The basics principles of optics which are necessary to understand and design optical components for EUV are taught in this week's lectures.

30 Oct. 2024

Week 4 | EUV optics II

The major optical components used in EUV optical systems are introduced from supposedly simple components like pinholes and grazing incidence mirrors to highly complex components like multilayer mirrors, Fresnel zone plates, and diffraction gratings.

06 Nov. 2024

Week 5 | Photolithography

EUV lithography is descendant from a living history of photolithographic technologies. You will learn about the technological aspects of photolithographic fabrication of integrated circuits and their facetted history. We'll also give a broader overview on different lithographic techniques for the generation of nanostructures both within and outside of (EUV) photolithography.

06 Nov 2024

Deadline for the upgrade to the verified track

13 Nov 2024

Week 6 | EUV metrology

While EUV can create nanostructures, EUV is also capable to investigate structures in the nanoscale. After starting off with photon detection techniques that are necessary for the measurement of EUV radiation you'll be given an overview of the metrological applications of EUV radiation e.g., in astronomy and nanosciences. This includes the chairs own metrology setups which apply EUV reflectometry and scatterometry.

20 Nov. 2024

Due date for the submission of all Assignments

26 Nov. 2024

Due date for all Peer Assessments

ASSESSMENTS & GRADING

Recap questions: After watching lecture videos, you will be asked to answer some questions relevant to the lecture which aims to help you practice and improve your knowledge.

Assignments: Every week we prepare an assignment for you. The tasks of the assignment will help you to connect the contents of every lecture with the larger picture of the section's topic and its importance to EUV technology.

Your percentage score in the **recap questions** makes up **40%** of your overall score.

Your percentage score in the **assignments** makes up **60%** of your overall score.

To receive a certificate, your overall score should be **at least 60%.**

DISCUSSION FORUM

If you have general questions, ask them in the general discussion forum. These forums are supposed to be an interactive environment in which you can ask your questions regarding the lectures, videos and share your ideas with other students and instructors.

ACADEMIC HONOR CODE

By participating in this course, you pledge to follow the edX honor code (https://www.edx.org/edx-terms-service). Explicitly, we expect you to be a diligent student and contribute to the course.

We believe it is not too hard to achieve a good grade when participating regularly and you will learn a lot about the topic at hand. We put a lot of effort in creating a great course for you and highly appreciate your feedback and suggestions!