EUV Lithography Short Course (June 5, 2022)

This course provides attendees with a full overview of the fundamentals, status, and technical challenges of EUV Lithography. Topics covered include EUV Sources, EUV Source Metrology, EUV Optics, EUV Systems and Patterning, and EUV Mask. We will begin with an overview of the history of EUVL and cover EUV sources, EUV source metrology and EUV optics, followed by a discussion of EUVL systems and patterning. We will cover the fundamental components of EUV systems and address similarities and differences in optical lithography systems. This section also covers patterning issues, including flare, LER, and resist performance. We will continue with an exploration of EUVL Mask technology issues such as design, materials (including reflective multilayers), process and metrology. Finally, we'll conclude with a Status Review of EUVL.

Registration Now Open!

https://euvlitho.regfox.com/2022-june-5th-euv-lithography-short-course

Course Material

Students are encouraged to purchase the text, EUV Lithography (2nd Edition, SPIE Press, 2018), directly from SPIE.

Learning Outcomes

Course attendees will be able to increase their fundamental understanding of:

- History and basics of the development of EUV Lithography
- Different EUV source types and current technical challenges of EUV source technology
- EUV source metrology and source power measurements
- EUV multilayer optics (History, modules -collectors, illuminator, projection optics, manufacturing, AIMS)
- EUV and High-NA EUV scanners
- EUV systems and patterning
- Key components in EUV systems and current technical challenges
- EUV mask technology and current technical challenges
- Status and technical challenges of EUV Lithography for supporting high volume chip manufacturing
- Commercial aspects of EUVL – how and when EUVL will be implemented, commercial opportunities, and the infrastructure landscape

Intended Audience

This short course is intended for anyone who is involved in the development of EUV Lithography and/or other emerging lithography techniques; needs to understand the current technology status of EUV Lithography; and is interested in learning the fundamentals of this leading NGL patterning technology.

Those who are responsible for the development of the roadmap for lithography in manufacturing and making technology decisions, as well as engineers and investors, will find this course valuable.

Detailed Course Outline

Module 1: Introduction to EUVL (Vivek Bakshi , *EUV Litho, Inc.*)

- Introduction to Lithography
- Moore's Law and ITRS
- Cost of Ownership
- Advantages of EUVL
- Key differences from 193 nm lithography
- List of Technical Challenges and Status

Module 2: EUV Mask (Jinho Ahn , *Hanyang University*)

- EUV mask structure and process flow
- Mask substrate
- Multilayer mirror deposition
- Absorber stack and pattern fabrication
- Mask inspection, metrology and repair
- Mask contamination protection and cleaning
- Advanced mask structure for better imaging

Module 3: EUV Sources (Vivek Bakshi,(*EUV Litho, Inc.*)

- EUV Source Technology Overview
- Definition, Overview, Joint Requirements
- Types of Source Technologies
    - Laser-produced plasma (LPP)
    - Fundamentals of LPP
    - Components of Sn LPP Source
    - EUV Power Scaling
    - Pre-pulse technology
    - EUV Collector and Debris Mitigation
    - Out-Of-Band Radiation
    - Discharge-produced plasma (DPP)
        - Fundamentals of DPP
        - Components of Sn DPP Source
        - Collector and Debris Mitigation
- Source Metrology
- Source Technology Status and Future Outlook

Module 4: EUV Optics (Patrick Naulleau , *CXRO, LBL*)

- History of lithography optics
- Early optical systems, prototypes and preproduction
- Optical modules for high volume manufacturing: collector, illuminator, projection optics
- Optics manufacturing
- AIMS EUV: core functionality

Module 5: EUVL Patterning (Patrick Naulleau , *CXRO, LBL*)

- Introduction
- EUV patterning capabilities and extendibility
- Current status of EUV resists
- EUV resists extendibility and shot noise

Module 6: EUVL and High NA EUVL Scanners (Jan B.P. van Schoot, *ASML*)

- **Architecture of the current EUV and next generation high-NA EUV scanners**
- **Comparison of EUV exposure tools with DUV/DUV-immersion tools**
- **Reason for the high-NA anamorphic concept**
- **Current status and future roadmap**

Instructors for One-Day Short Course

- **Vivek Bakshi (EUV Litho, Inc.)**

  Dr. Vivek Bakshi is the president of EUV Litho, Inc. an organization he has formed to promote EUV Lithography via consulting, publications, education and workshops. Previously he was a Senior Member of Technical staff in the Lithography Division of SEMATECH. He has edited two books on EUV Lithography: *EUV Sources for Lithography* (SPIE Press, 2006) and *EUV Lithography* (SPIE Press and John Wiley & Sons, Inc., 2008). He is an internationally recognized expert on EUV Source Technology and EUV Lithography. He is the lead instructor for the course and the author of the EUV Source Technology chapter in the book *EUV Lithography*.

- **Jinho Ahn (Hanyang University)**

Dr. Jinho Ahn joined Hanyang University in 1995 as a professor in the MSE department. He has been working as a national project leader for EUVL technology. He is now serving as a Director for Nano & Convergence Technology of National Research Foundation of Korea.

- **Patrick Naulleau (CXRO, LBL)**

Dr. Patrick P. Naulleau has been involved in EUV lithography since 1997 when he joined Lawrence Berkeley National Laboratory (LBNL) to work in the area of actinic interferometric alignment. Since 2001 he has lead LBNL's EUV Patterning project starting with the 0.1-NA ETS optics and now the 0.3-NA MET optic. He is internationally recognized for leading EUV patterning studies and his contributions to EUV System designs. He is the lead author of chapter on EUV Patterning in the book EUV Lithography.

- **Jan B.P. van Schoot, PhD (ASML)**

Jan B.P. van Schoot, PhD, is Director of System Engineering and Technical Specialist at ASML, based in Veldhoven, The Netherlands.

After his study Electrical Engineering (Cum Laude) at Twente University of Technology. He received his PhD in Physics on the subject of non-linear optical waveguide devices in 1994 and held a post-doc position studying waveguide based electro-optical modulators.

He joined ASML in 1996 and was Project Leader for the Application of the first 5500/500 scanner and its successors up to 5500/750. In 2001 he became Product Development Manager of Imaging Products (DoseMapper, Customized Illumination). In 2007 he joined the dept of System Engineering. He was responsible for the Optical Columns of the 0.25NA and 0.33NA EUV systems. After this he worked on the design of the EUV source. He was the study leader of the High-NA EUV system and is now responsible for the High-NA optical train.

He is a Sr. Member of the SPIE, holds over 35 patents and presents frequently at conferences about photolithography.