EUV Lithography Short Course (7 AM – 2 PM, October 23, 2021)

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. Next is a discussion of EUVL systems and patterning. We cover the fundamental components of EUV systems and address similarities and differences to optical lithography systems. This section also covers patterning issues including flare, LER, and resist performance. We continue with an exploration of EUVL Mask technology issues such as design, materials including reflective multilayers, process and metrology. Finally, we conclude with a Status Review of EUVL.

Registration Link

EUV Lithography Short Course (October 23rd, 2021) Registration

Course Material

Students are encouraged to purchase the texts, EUV Lithography (2nd Edition, SPIE Press, 2018) directly from SPIE. Printed copy of the lecture notes can be provided at the cost of printing and shipping, after the short course. If you are interested in getting a copy, please write to us at info@euvlitho.com.

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 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 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 (One Day Course)

Module 1: Introduction to EUVL

- 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

- 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

- 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

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

Module 5: EUVL Patterning

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

Module 6: Summary

- EUVL –The Big Picture
- EUVL Technology Status
- EUVL Technology –Opportunities
- EUVL Extension
- Announcements and Q & A

Instructors for One-Day Short Course

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

Dr. Vivek Bakshi is the founder and president of EUV Litho, Inc., an organization he formed in 2007 to promote EUV Lithography via consulting, workshops and education. Previously, he was a Senior Member of the Technical Staff in SEMATECH's Lithography Division. Dr. Bakshi has published four books on EUVL: *EUV Sources for Lithography* (SPIE Press, 2006), *EUV Lithography* (SPIE Press and John Wiley, 2008), *Extreme Ultraviolet Lithography* (SPIE Press, 2012 (co-edited with Anthony Yen). His latest book *EUV Lithography - 2nd Edition* (SPIE Press, February 2018) is a best seller for SPIE press. His forthcoming book *Photon Sources for Lithography and Metrology* will be published by SPIE Press in 2022.

- **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.

- **Sascha Migura (Carl Zeiss) – Guest Instructor**

  Sascha Migura has been employed by Carl Zeiss SMT GmbH since finishing his PhD in physics in 2006 at the University of Bonn. He mainly worked on EUV lithography optics and was responsible for the optical designs of the Starlith® 3100 and Starlith® 3300. Sascha Migura was also Lead System Engineer of the pre-development of the High-NA EUV lithography optics.