



Center for Hyperscale, Hyperfunction, Heterogeneous
Integration Pioneering Semiconductor Technology (CH³IPS)

EUV Lithography Empowered by Nanotechnology

Jinho Ahn

President, Korea Nanotechnology Research Society
Executive Vice President for Research, Hanyang University
Director, CH³IPS Innovation Research Center

We are now facing many complex crises

Low birth rate and aging population



Service robot



Innovative new drug

Global Pandemic

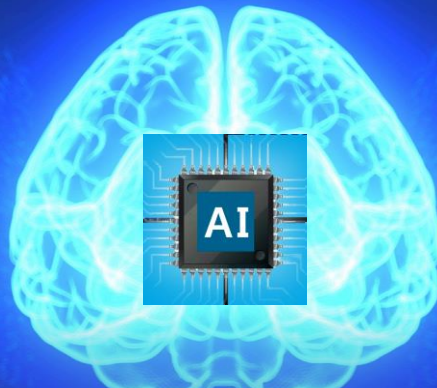
Energy and Environmental Issues



Eco-friendly mobility

Semiconductor technology is at the core of innovative solutions

A.I. Semiconductor



Natural Language Processing



Advancement in
AI models

Urban Air Mobility (UAM)



Massive
compute power

New Drug Development



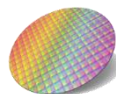
Large amounts of
data

With the acceleration of the Fourth Industrial Revolution,
the semiconductor industry remains a sustainable strategic sector

Projected Annual Growth Rate of Global Semi. Market ('23~'28)

(OMDIA, '24.6)

- Total Semiconductor Market : 10.8% ('23)544 B\$ → ('28)908 B\$
- Memory Device Market : 24.2% ('23)94 B\$ → ('28)279 B\$
- System IC Market : 7.3% ('23)359 B\$ → ('28)512 B\$



Korean Semiconductor Industry ('23)

(Korea Customs Service, '2024 . 1)

- No. 1 export item for 11 consecutive years since 2013
 - ※ For 20 of the past 27 years, it has been a core national industry and strategic sector driving the country's exports
- Proportion within Top 10 export items of 2023 : ~15.3%



US

- CHIPS and Science Act ('22.8.9)
 - Support \$52.7 billion for domestic semi. manufacturing facilities
 - Samsung(6.4B), Intel(8.5B), TSMC(6.6B), Micron(6.1B)



EU

- EU Chips Act ('23.4.19.)
 - € 43 billion support for semiconductor industry by 2030
 - aims to double its global semiconductor market share to 20%



Japan

- Plan to strengthen the semiconductor industry ('21.6)
 - ¥1.2 trillion for TSMC Fab. construction, ¥920 billion for Rapidus
 - Aiming to triple semiconductor production to \$96.3 billion by 2030

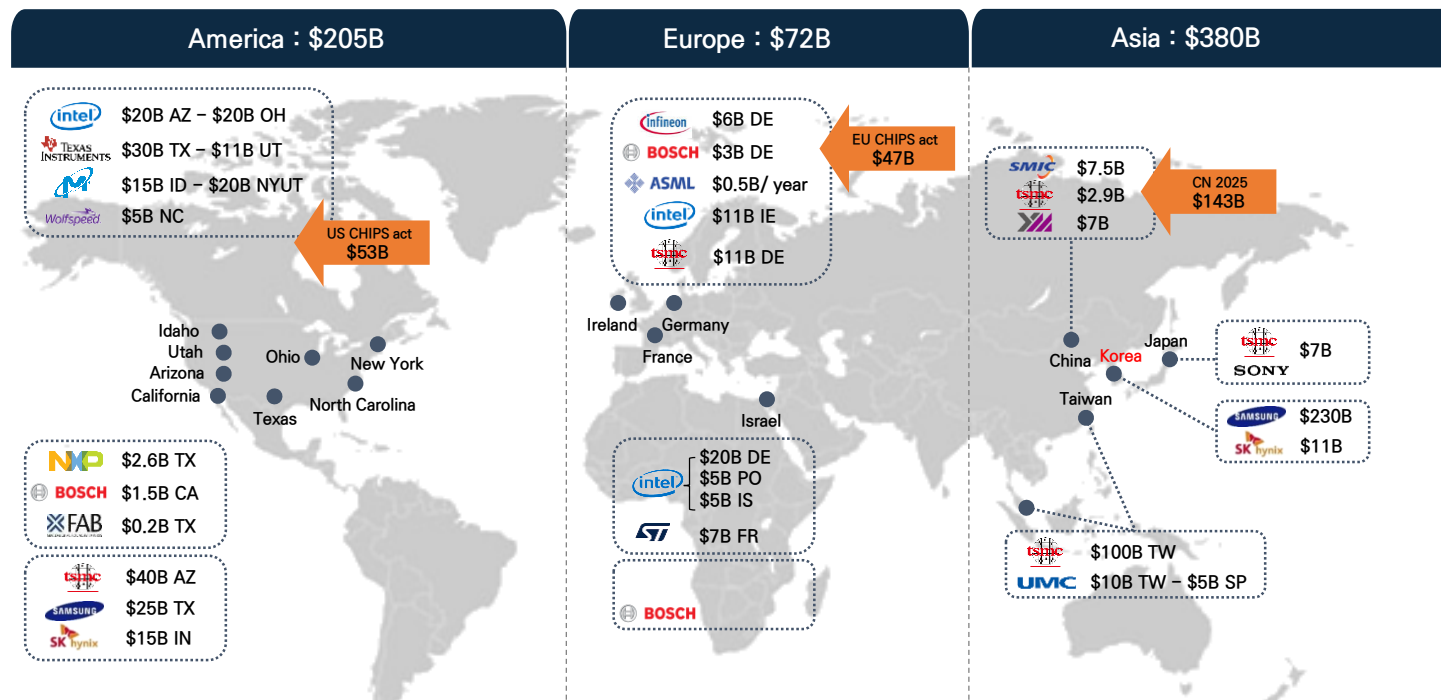


China

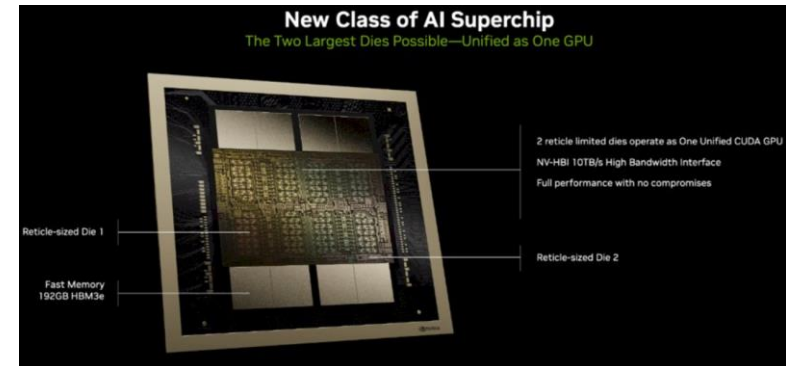
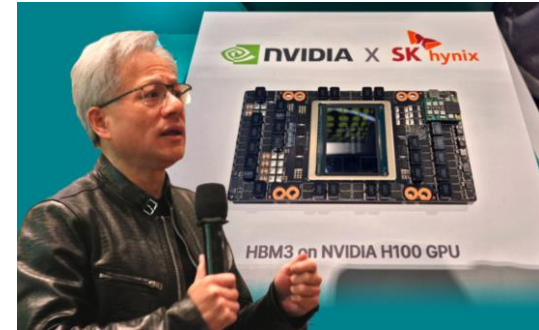
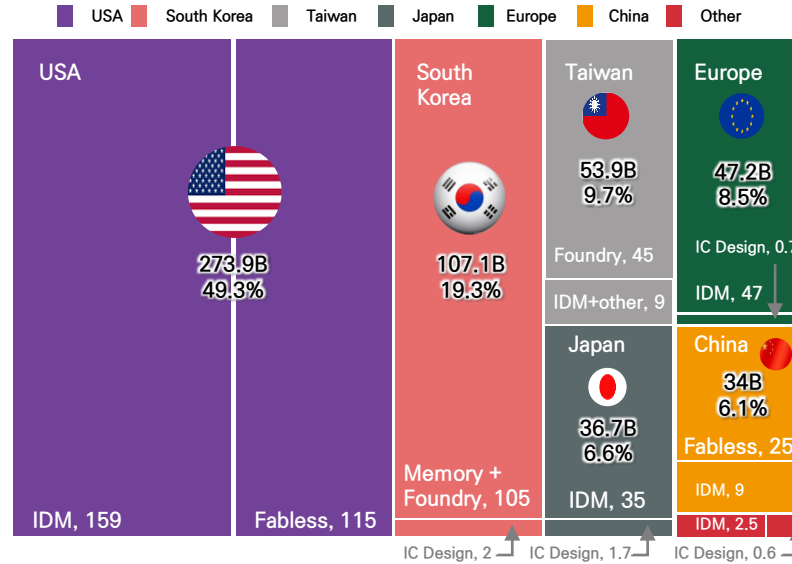
- Targeting 70% semi. self-sufficiency by 2025 (17% in 2021)
 - Currently investing \$142 billion in the semiconductor industry
 - Raising an additional \$27 billion for SMIC and Huawei

Investment Landscape in the Semiconductor Industry

U.S.-driven semiconductor supply chain restructuring and Global Investments for the Survival of the Semiconductor Industry



Global TOTAL : ~\$800B



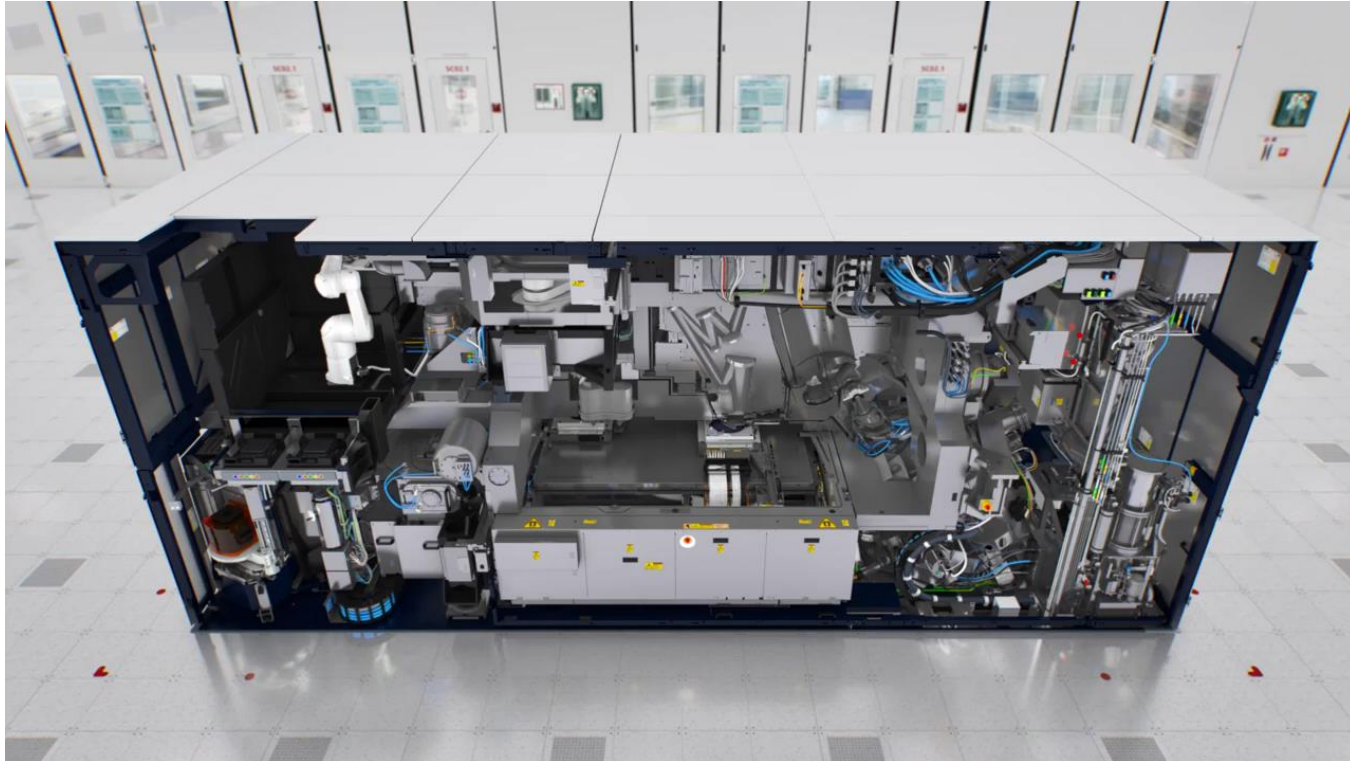
Semiconductor Device is a complicated 3D nano-structure

Higher Performance
Higher Integration Density
Smaller Feature Size



Key Technology for Integration : EUV Lithography

EUV Scanner adopts reflective optics !

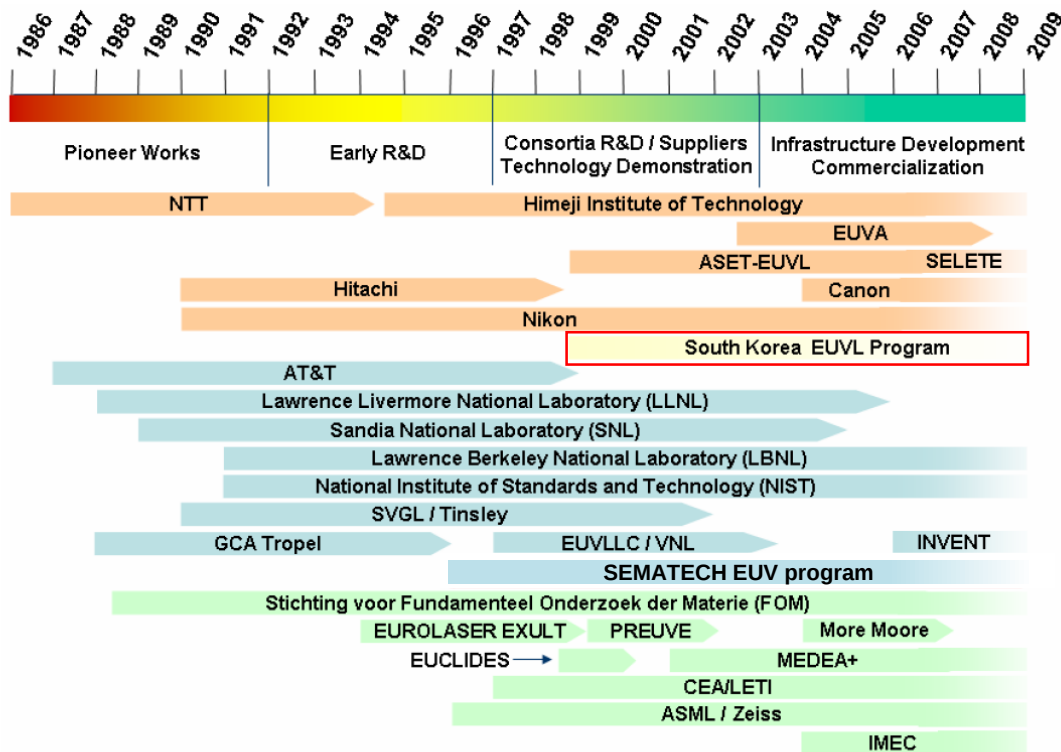


EUV is in High Volume Manufacturing



- ✓ EUV lithography is already being applied to mass production
- ✓ > 4 EUV layers in DRAM production, > 12 layers for logic device
- ✓ Process improvements are underway for better resolution, pattern quality, process yield, and productivity

Worldwide EUVL R&D project



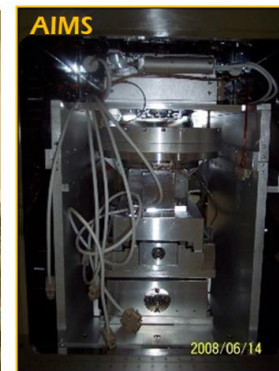
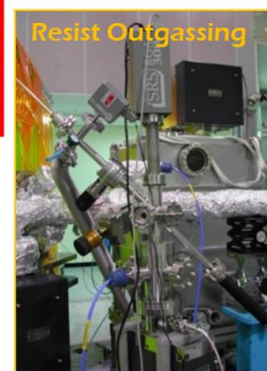
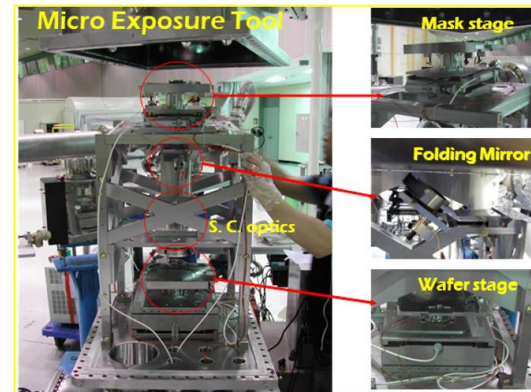
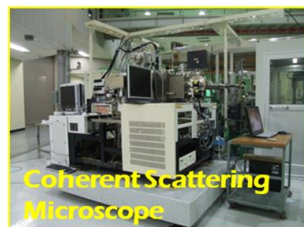
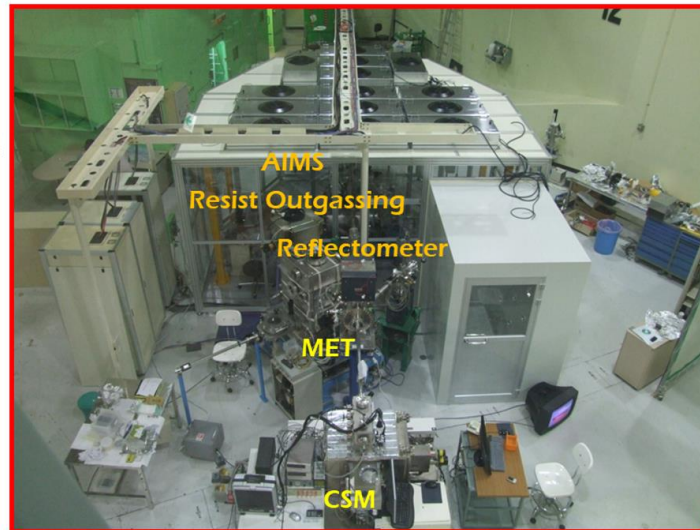
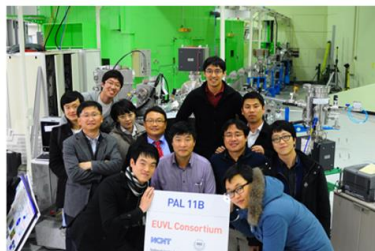
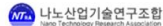
Legend: ■ Japan ■ South Korea ■ U.S.A. ■ Europe

S. Wurm, EUVL Development History

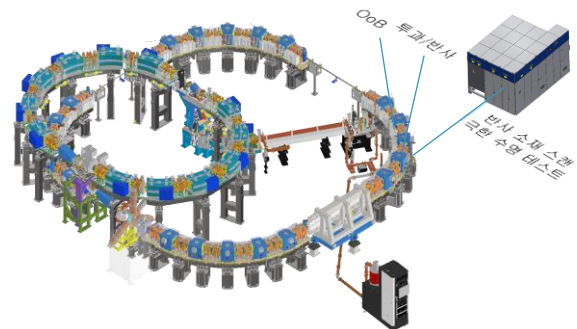
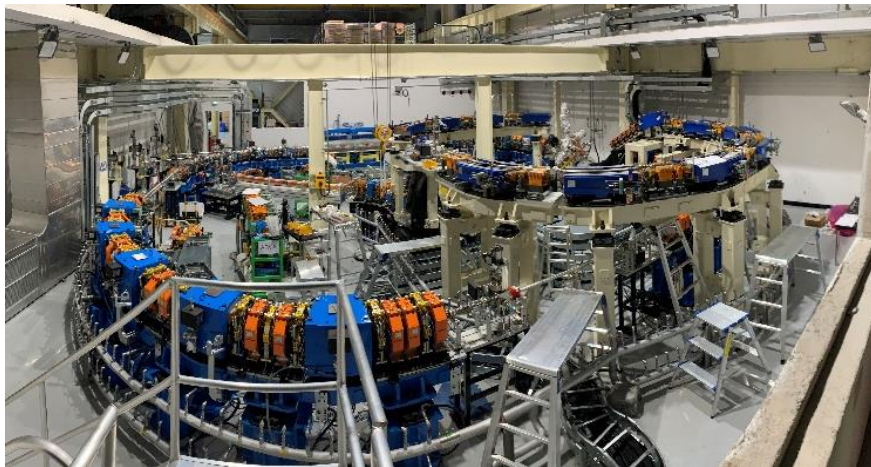
The First EUVL R&D Consortium in Korea (2002-2011)

차세대신기술개발사업
나노급 반도체용 EUV리소그라피 핵심기술 개발

산업부차세대신기술개발사업단

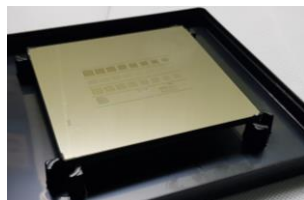
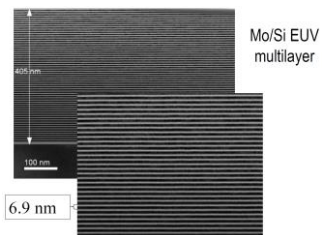


New EUV Beamline at Pohang Synchrotron Facilities

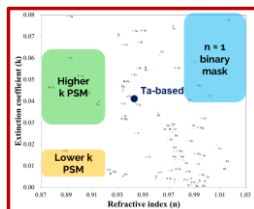


Mask Design & Fab.

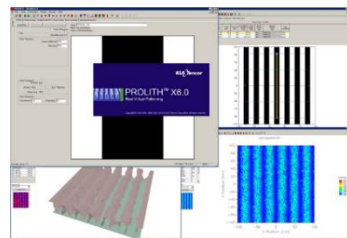
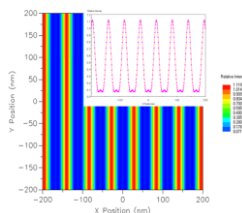
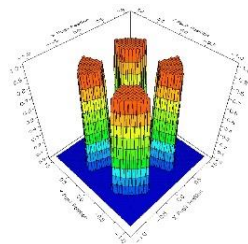
Multilayer



Next Gen. EUV Absorber



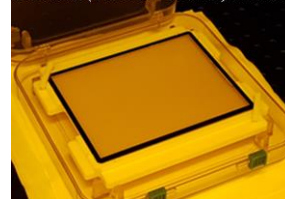
Optical Simulation



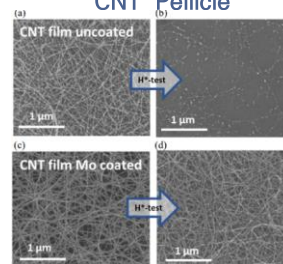
Pellicle Design & Fab.

EUV Transmittance >90%

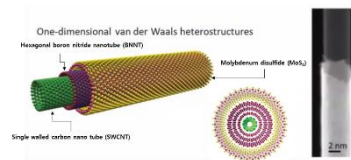
Full-size (110mm * 144mm) Pellicle



CNT Pellicle

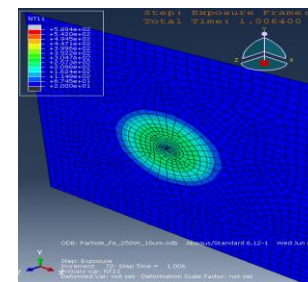


Coating on CNT

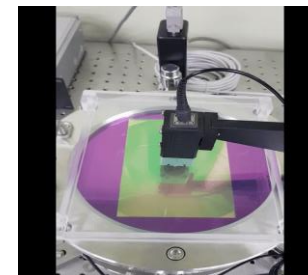


Thermo-Mechanical Property Evaluation

Thermo-mechanical Simulation

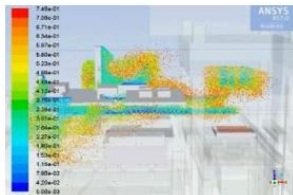


Bulge Test (Fracture Behavior)

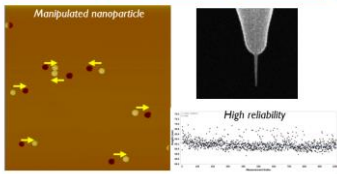


Contamination Analysis & Cleaning

Particle behavior in chamber

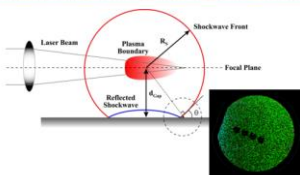


Particle manipulation by AFM Nanomanipulation with high reliability



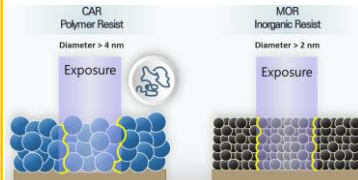
Lase Shock Wave Cleaning

Point Selective Laser Shock wave Cleaning

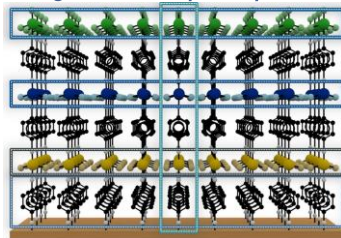


New Resist Structure

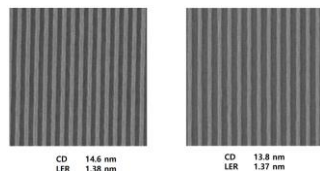
Line edge Roughness



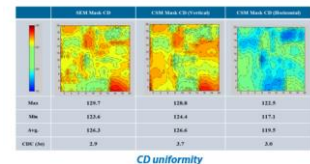
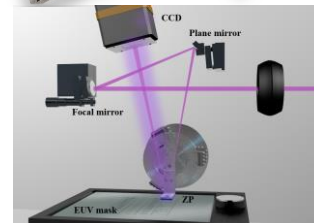
Vertically aligned Organic-Inorganic Multilayer Dry Resist



Low CD & LER



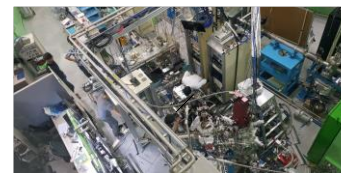
Optical Evaluation (Refl./Trans./Imaging)



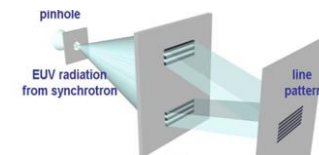
EUV Resist Evaluation



Resist sensitivity

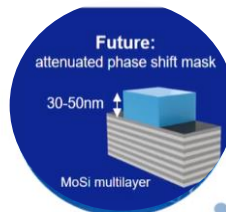


Interference Lithography



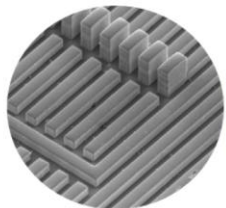
Mask

Research on advanced materials for phase shift mask and thin absorber mask



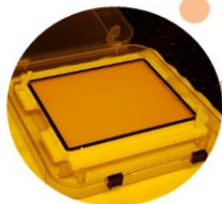
Resist

Inorganic/organic resist materials and dry development



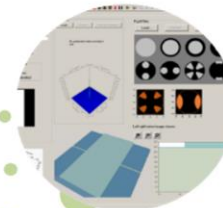
Pellicle

Design, fabrication, evaluation of new materials providing compatibility with high-power EUV source



Simulation

Optical, thermal, mechanical simulation for mask and pellicle



Cleaning

Wet and dry cleaning process for mask and pellicle



Metrology and Inspection

Coherent Diffraction Imaging of mask patterns, Transmittance & reflectance





Academia & Research Institutes

- Hanyang University
- Inha University
- Pohang Accelerator Laboratory
- Korea Electronics Technology Institute
- The University of Texas at Dallas (U.S.)
- SUNY Polytechnic Institute (U.S.)
- Paul Sherrer Institute (Switzerland)

Industry Members

- ASML Korea
- FST
- S&S Tech
- ESOL
- Young Chang Chemical
- QRT
- Taihan Fiber Optics
- Veeco Korea
- Lam Research Korea
- Hunet Plus
- PSK
- EGTM
- DNF
- Nextin Solution
- Dongwoo Finechem
- Park Systems
- TEL Korea
- BASF Korea
- PeDiSem
- Kairo Space
- Next IJ
- The Elec
- Alpha ADT
- HIMS
- TDNJ
- Mitsui Chemicals Korea
- Derkwoo
- Carl Zeiss
- Graphene Square
- IMT
- Graphene Lab

For more information.
Please visit our website.
<https://www.euv-iucc.org>



한양대학교
HANYANG UNIVERSITY



CH³IPS
Center for Hyperscale · Hyperfunction · Heterogeneous
Integration Pioneering Semiconductor Technology

We look forward to collaborations

Jinho Ahn

Professor, Materials Science and Engineering
Executive Vice President for Research, Hanyang University
Director, CH³IPS Innovation Research Center

