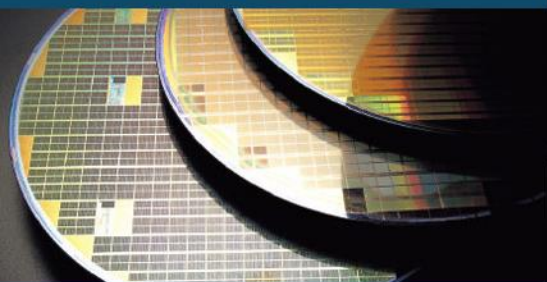


High-Throughput Nanomanufacturing Using EUV Lithography

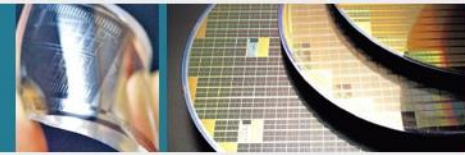


Prof. Jinho Ahn

Division of Materials Science & Engineering
Hanyang University

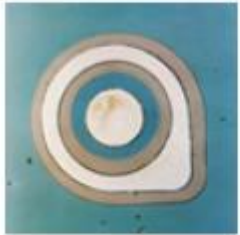
September 29, 2014

Integrated Device



1950s

Silicon
Transistor



1
Transistor

1960s

TTL
Quad Gate



16
Transistors

1970s

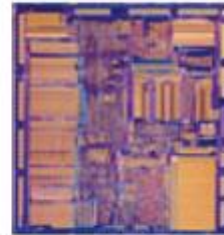
8-bit
Microprocessor



4500
Transistors

1980s

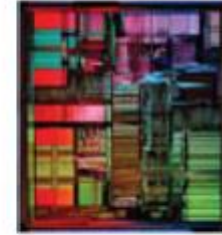
32-bit
Microprocessor



275,000
Transistors

1990s

32-bit
Microprocessor



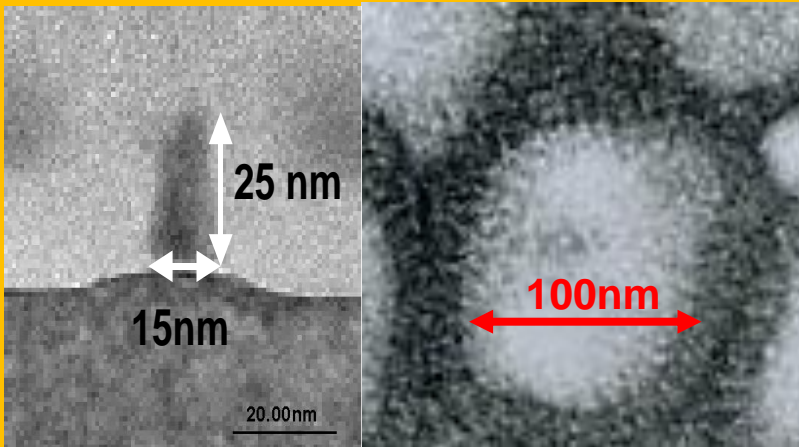
3,100,000
Transistors

2000s

64-bit
Microprocessor



592,000,000
Transistors



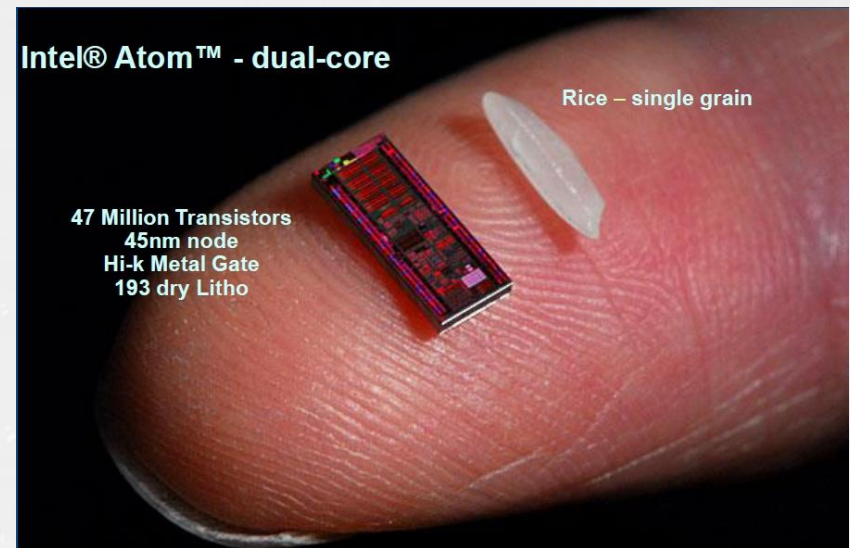
22nm-tech TR.

Influenza virus

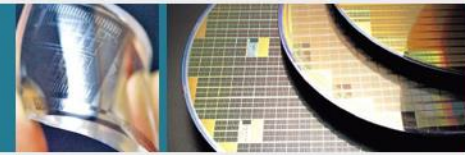
Intel® Atom™ - dual-core

47 Million Transistors
45nm node
Hi-k Metal Gate
193 dry Litho

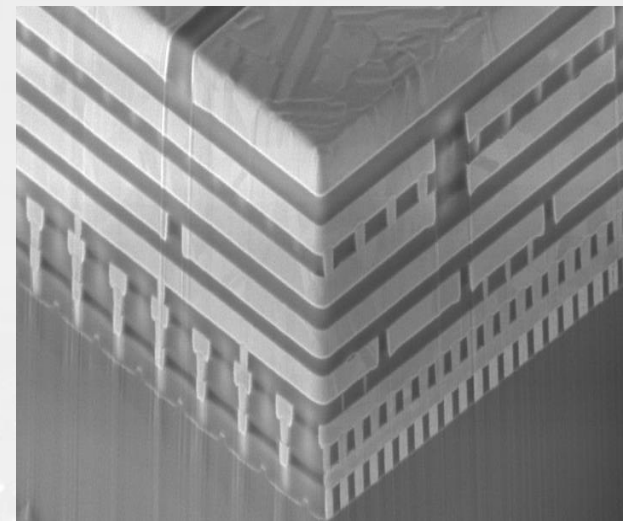
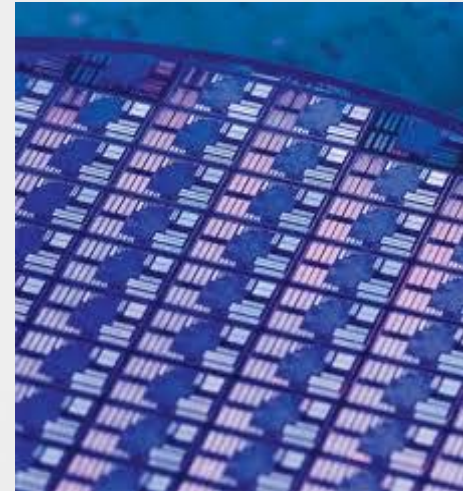
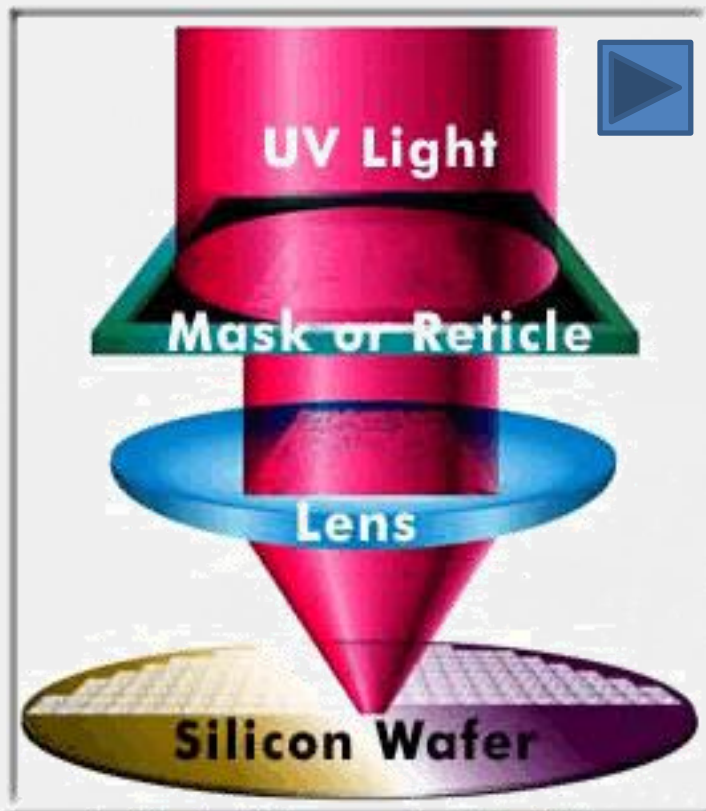
Rice – single grain



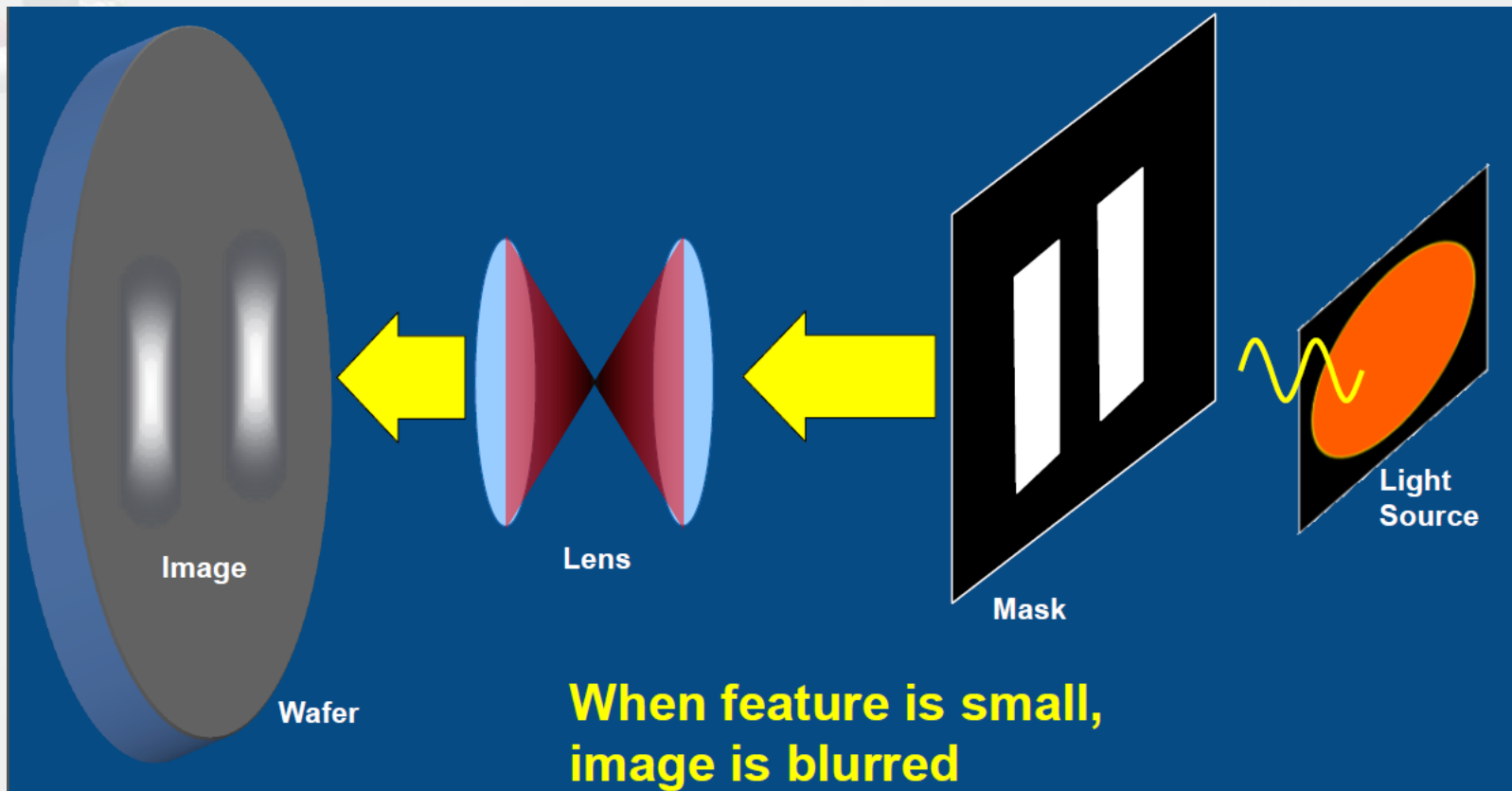
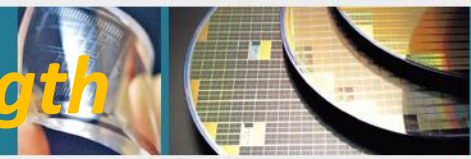
Lithography Technology



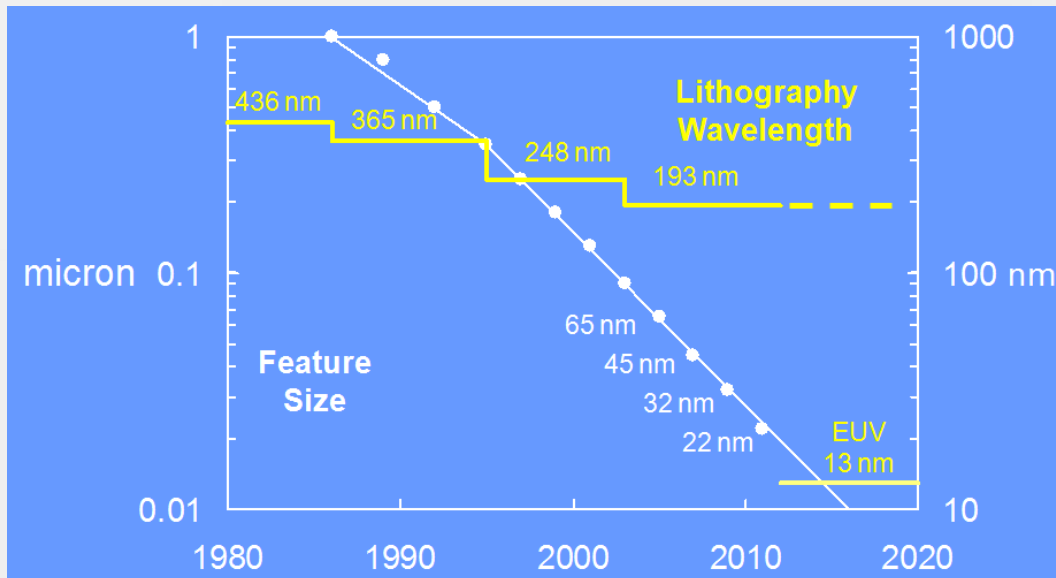
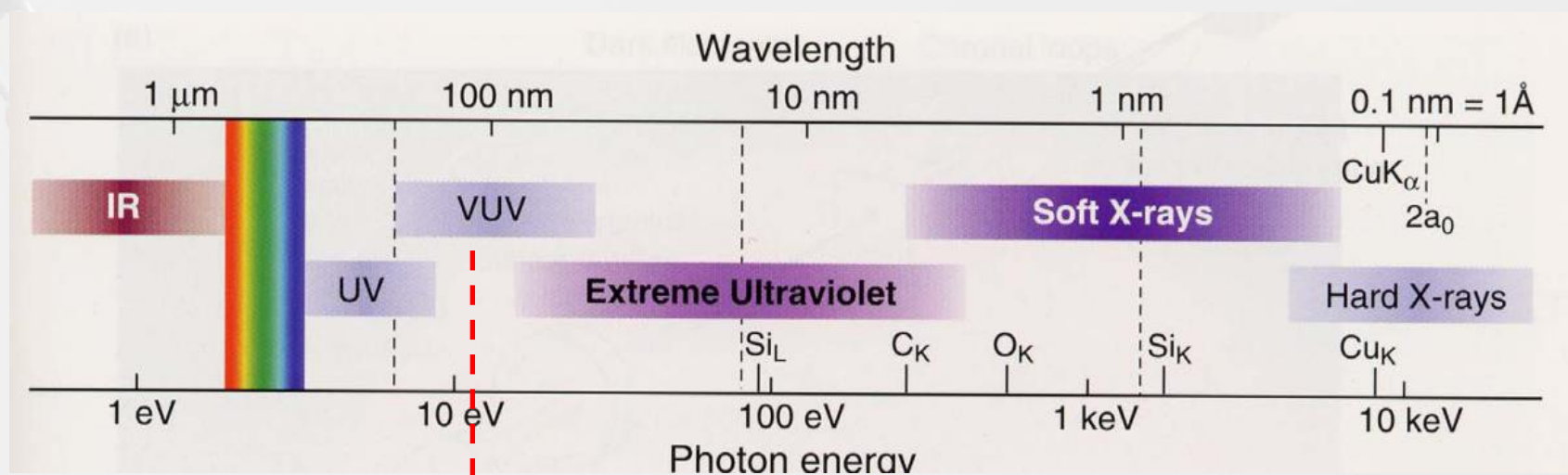
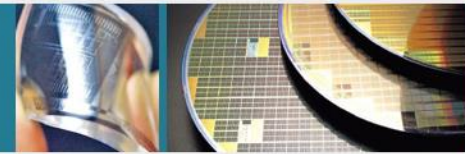
*Lithography - Core Technology
for Device Shrinking & Integration*



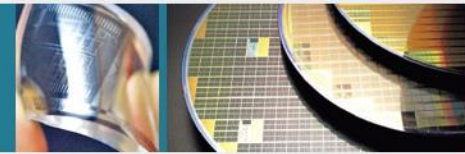
Resolution Limit depends on wavelength



Light Source for Lithography

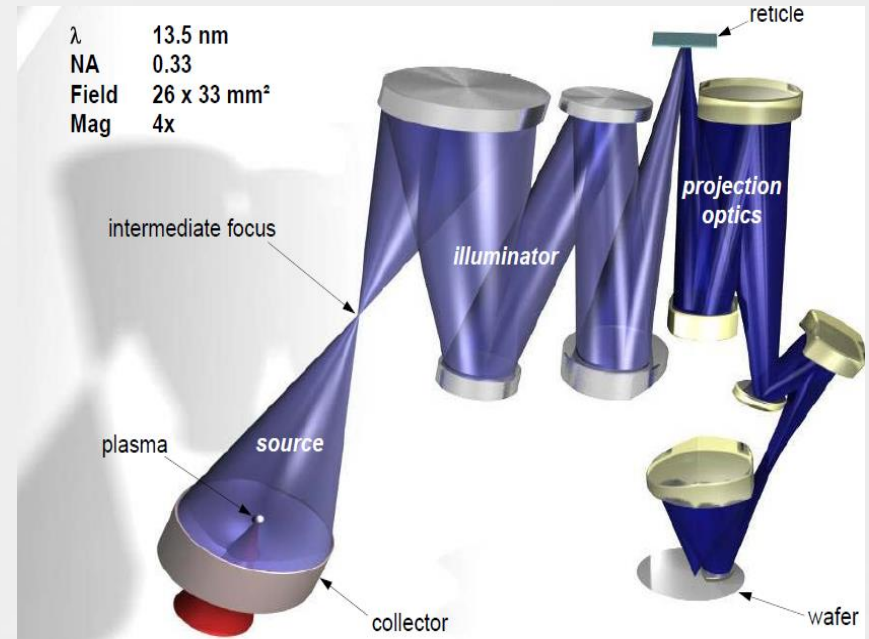


Extreme UV (EUV) Lithography



$$\text{Resolution} = k1 \frac{\lambda}{NA}$$

λ : 193nm \rightarrow 13.5 nm



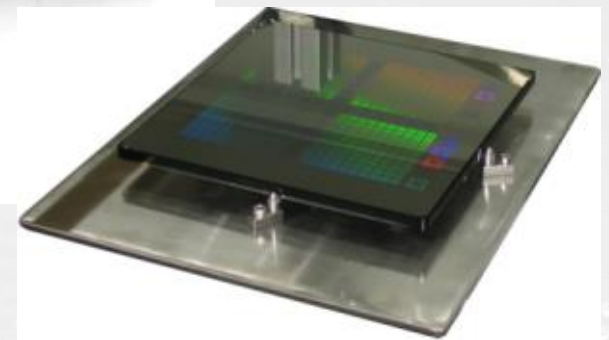
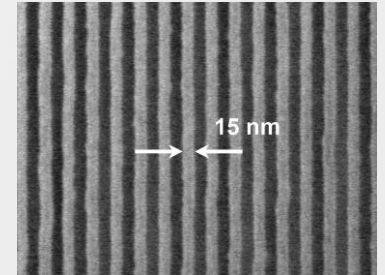
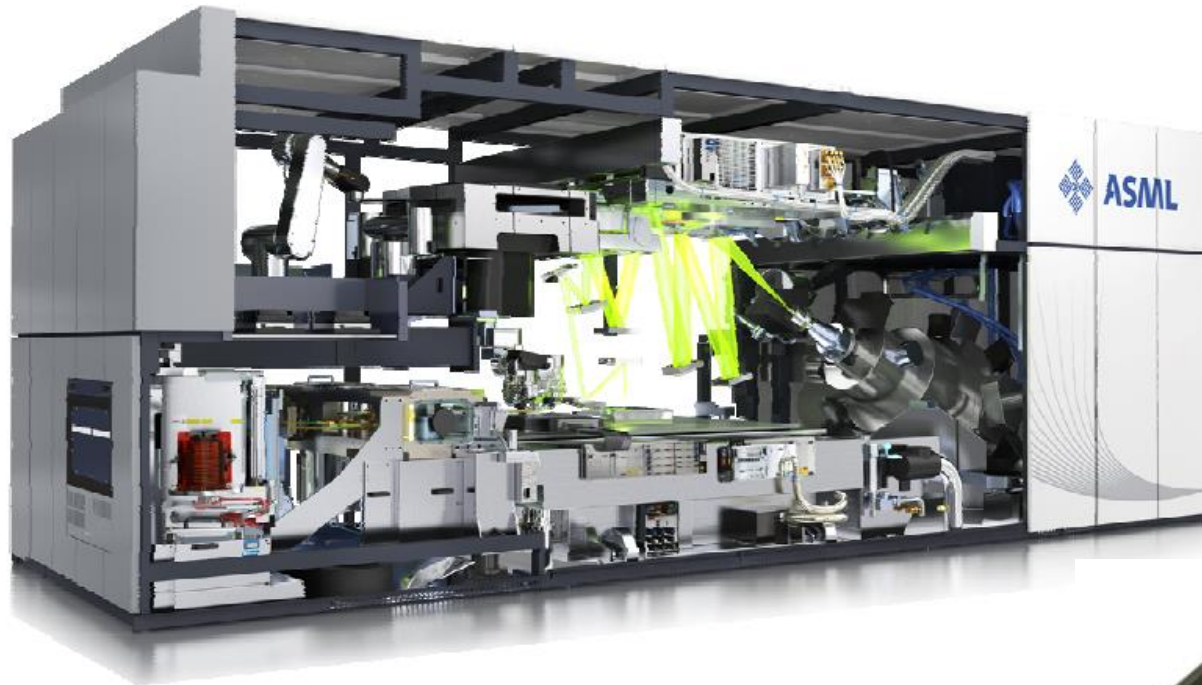
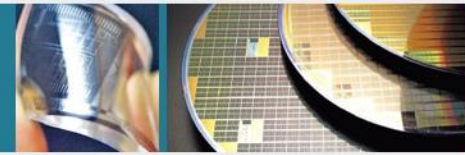
K1=0.25
32nm hp @ArF Immersion



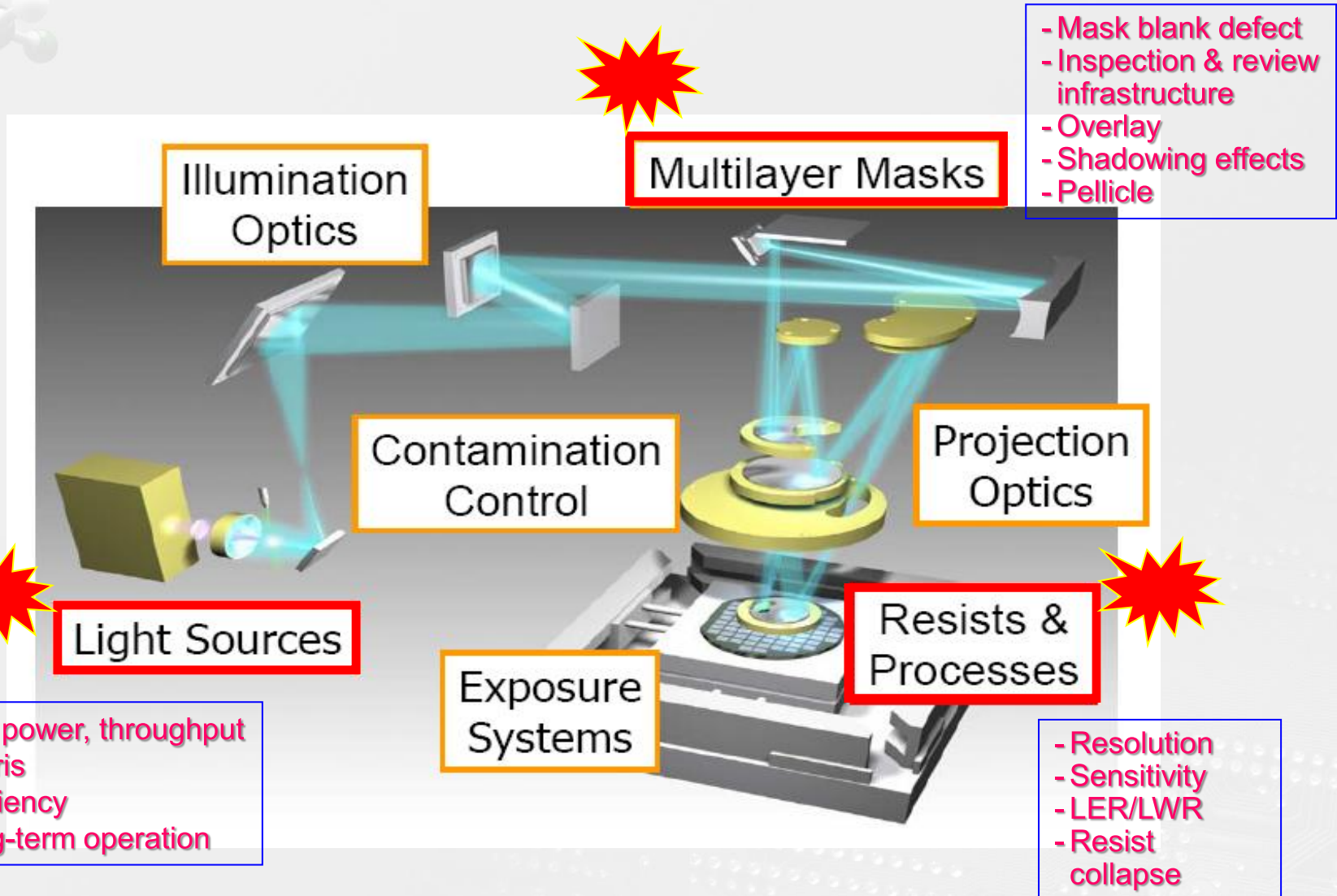
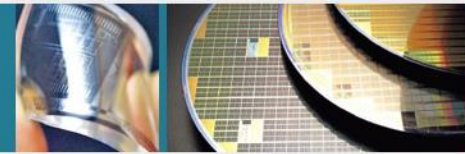
K1=0.59
32nm hp @EUVL NA0.25



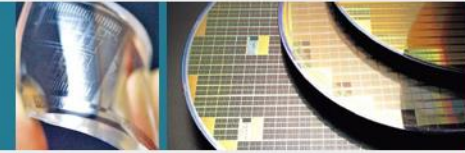
EUV Stepper and EUV Mask



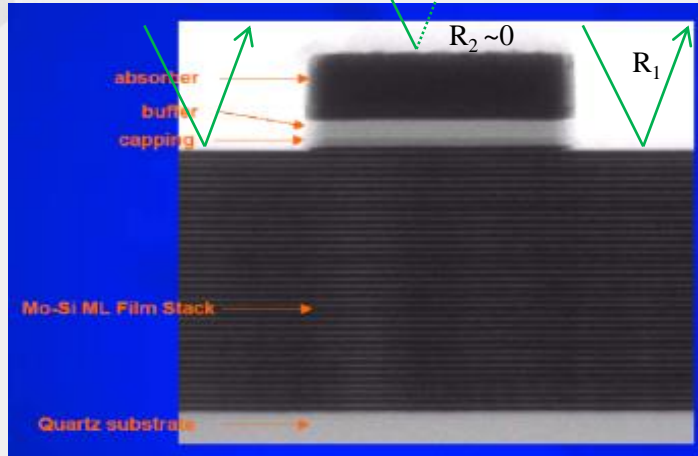
Element Technology & Issues



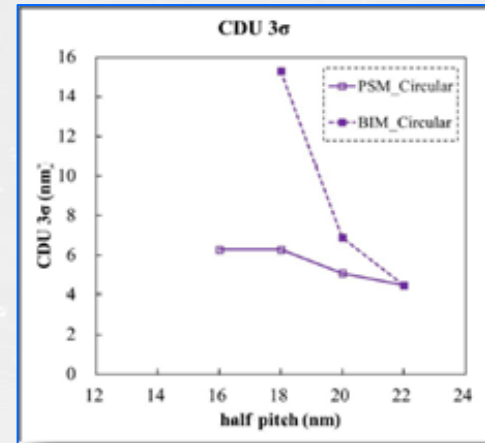
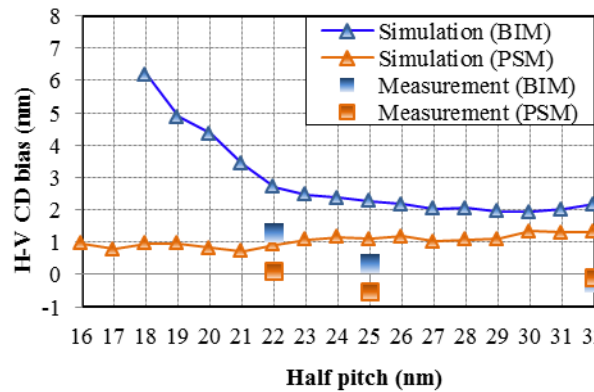
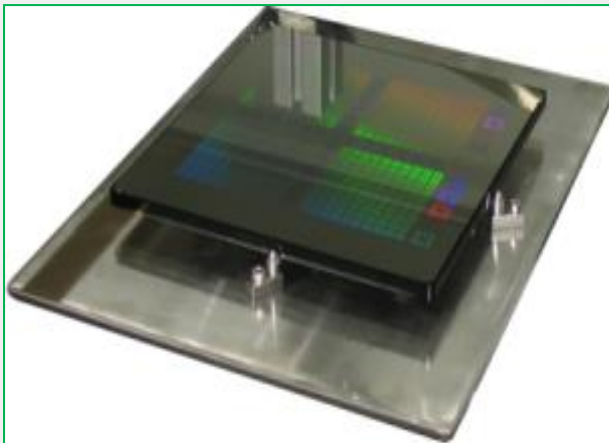
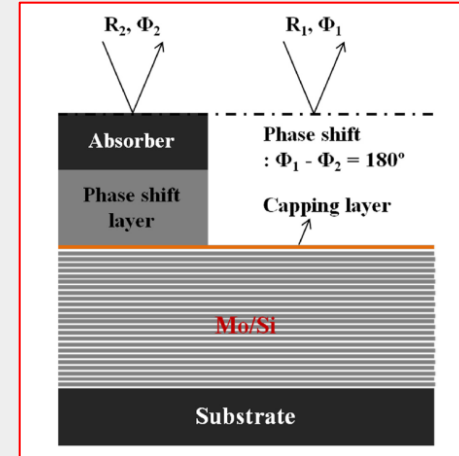
Our Work : EUV Phase Shift Mask



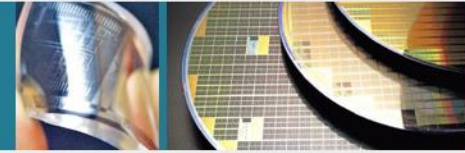
Gen. 1: Binary Mask



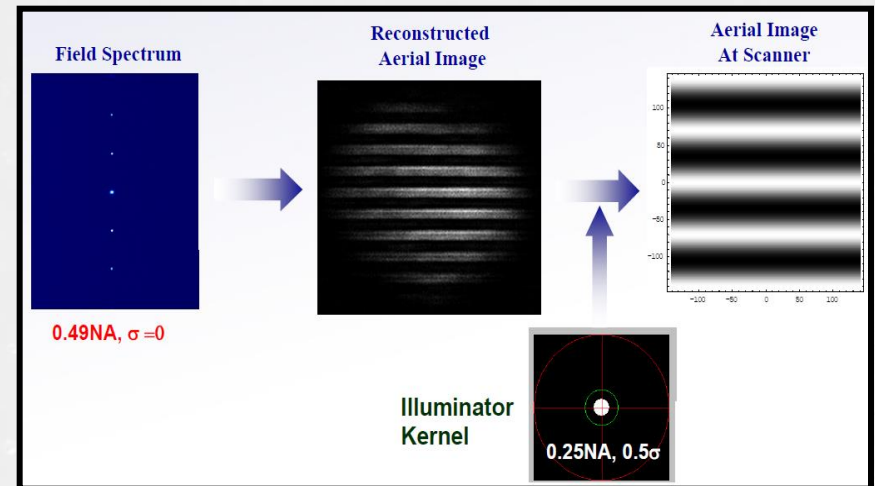
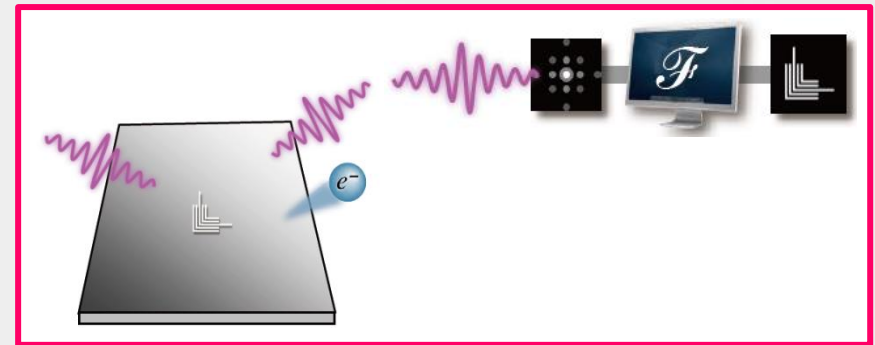
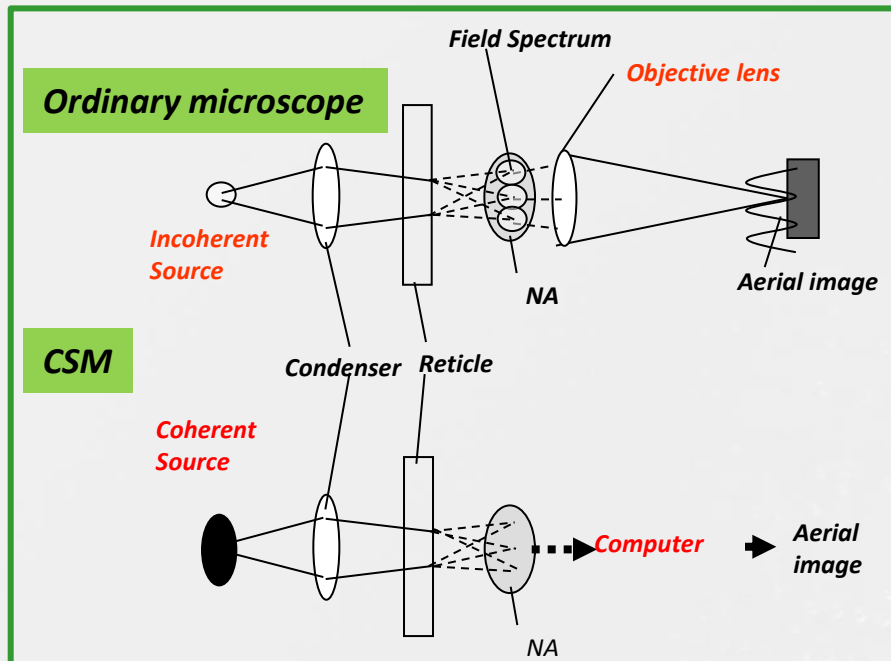
Gen. 2: Phase Shift Mask



Our Work : New EUV Microscope

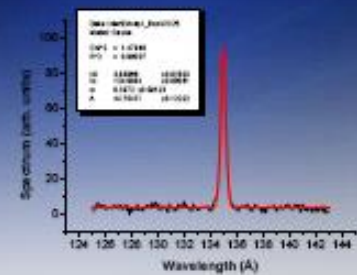
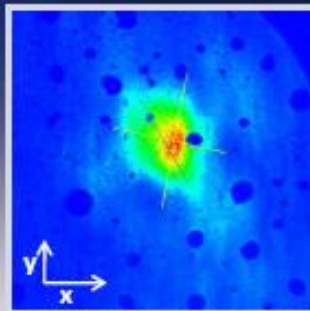
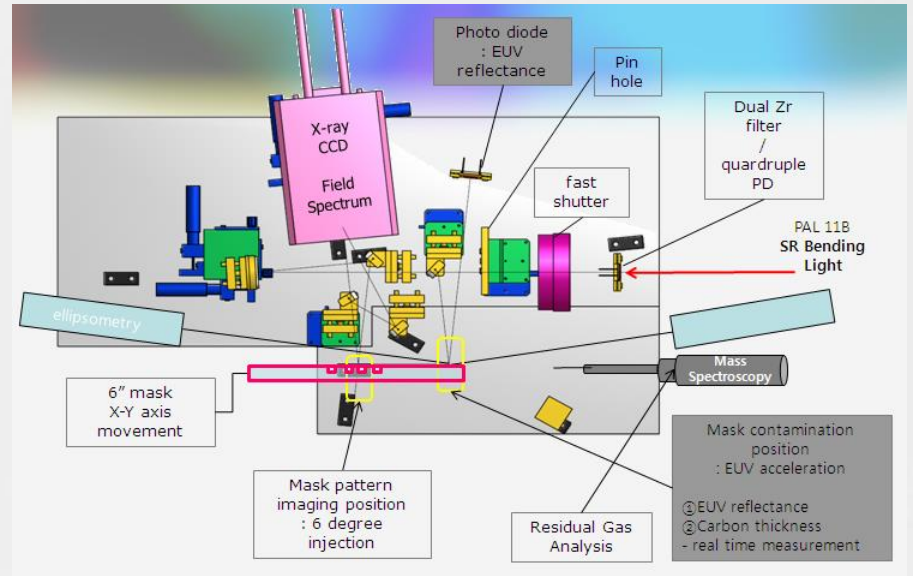


Coherent Scattering Microscope: Lensless Computational Microscope

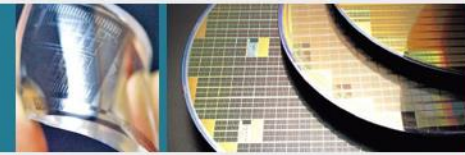


Our Original CSM

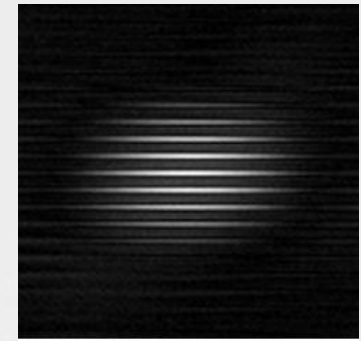
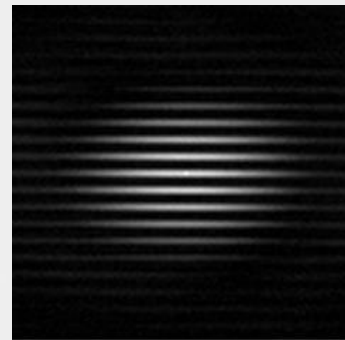
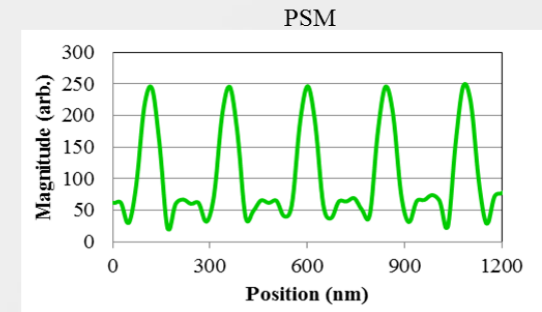
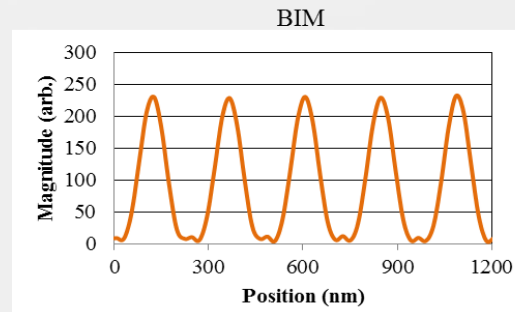
Collaboration with domestic partners



Mask Inspection with CSM



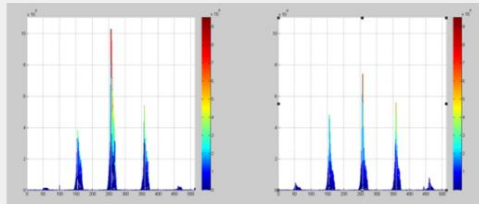
Coherent Scattering Microscopy



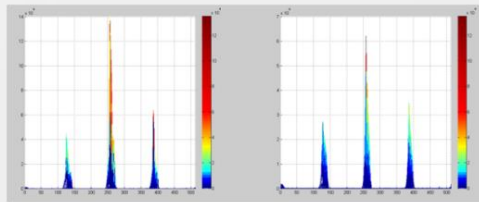
Binary

PSM

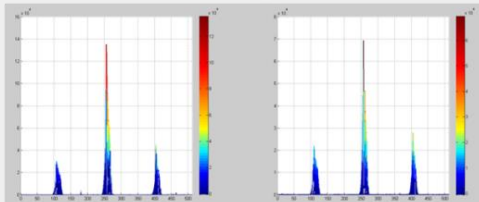
128nm
L/S HP



100nm
L/S HP

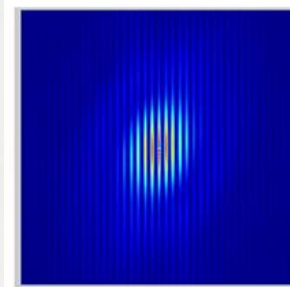
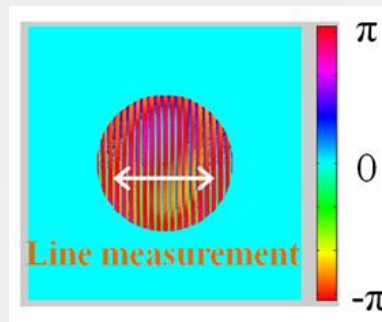


88nm
L/S HP



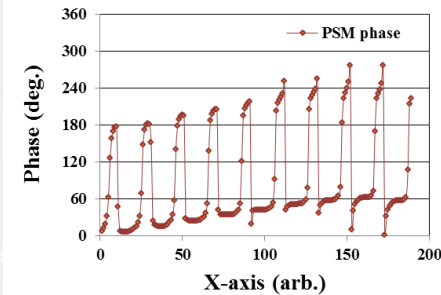
BIM

PSM



Phase map

Magnitude map



Phase profile

Inspection of fabricated EUV masks; binary intensity mask (BIM) and phase shift mask (PSM)

A group of hikers is seen from behind, walking along a snowy ridge. They are wearing winter gear and carrying backpacks. The landscape is a vast, white snowfield under a clear blue sky. A bright sun is positioned at the top center, creating a starburst effect with rays extending across the sky. Below the hikers, a thick layer of white clouds fills the valley, creating a sea of clouds effect. The overall scene is bright and clear, suggesting a high-altitude mountain environment.

***Thank you
for your attention***