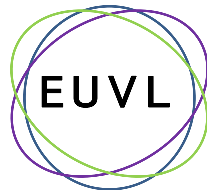
2014 June 25th EUVL Workshop in Maui

Recent Activities in Japan



University of Hyogo
Center for EUV Lithography
H. Kinoshita

Recent Activities in Japan

Source: Gigaphoton, Mitubishi electric Co.
Mask:AGC, HOYA, DNP, Toppan
Mask Inspection: EIDEC, LaserTech, University of Hyogo、
Resist: EIDEC,Osaka University, University of Hyogo
Shinetsu,Tokyo Ouka、JSR, Fuji, etc.
Pellicule: some companies
Device: Toshiba

Approach for "Effective" Phase Defect-free Blank

TDI camera

scattering ray by defect

SS optics

EUV light

EUV blank

TDI camera

mini-environment loading stage

main chamber optics inside

EUV source

ABI-Tool

Defect Inspection

2-2. LTEM-ML blank defect trend @50nm SiO2

Ru-ML blank defect reduction trend and plan

Responsibility of Blank Suppliers

Defect Reduction

Bump defect

Pit defect

Multilayers

substrate

substrate

Resist patterns (Phase defect) / Mask	Lx ~ -hp	Lx ~ -hp/2	Lx ~ 0	Lx ~ hp/2	Lx ~ hp
26 nm L&S W=80 nm D=1.9 nm					
24 nm L&S W=80 nm D=1.9 nm					
22 nm L&S W=70 nm D=1.8 nm					

CD impact (Scanner & simulation)

CD Printability

(Real Defect Traceability)

EUV Source

CCD

NA=0.25 x1480 optics w/ 4 mirrors

EUV microscope
(Tohoku University)

Defect Characterization

Aperture

EUV CCD Camera

Focusing optics

Off-Axis FZP

EUV

EUV Mask (Blank)

Phase Defect

m-CSM
(University of Hyogo)

	#19	#20	#22	#25
AFM	FOV 1.5um, 200 nm	FOV 1.5um, 200 nm	FOV 1.5um, 200 nm	FOV 1.5um, 200 nm
Micro-CSM	logscale	log scale	log scale	log scale

Diffraction patterns to various figures

Defect Mitigation

shifting layout

Review mode
(Area where defects are detected)

~ 5 min
for 10 defects

M2 = b/a = 46.15

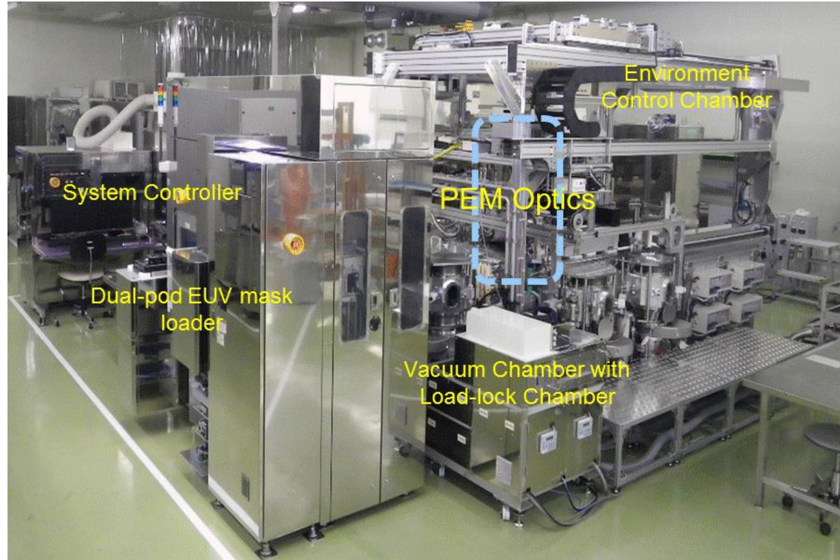
2nd concave mirror

M1·M2 = 1200x

age acquisition by review optics

Patterned Mask Inspection Update

Overview of PI tool

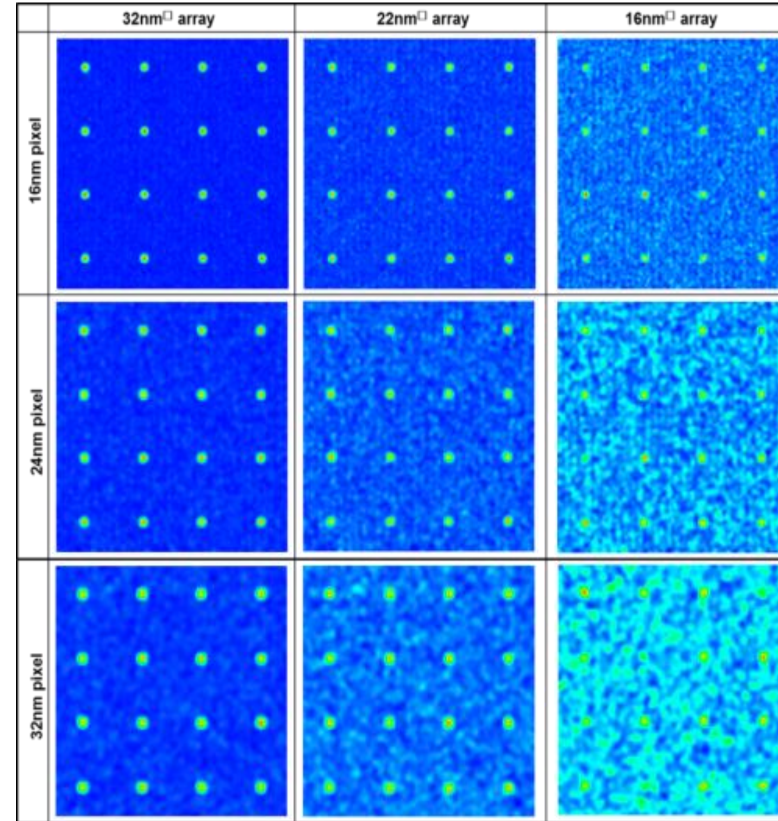


Specification of PI tool for hp 16 nm generation

Attribute Item	Specification
Defect sensitivity	16 nm
Inspection time	19 hours

Pixel size 16 nm
Data speed 600MPPS

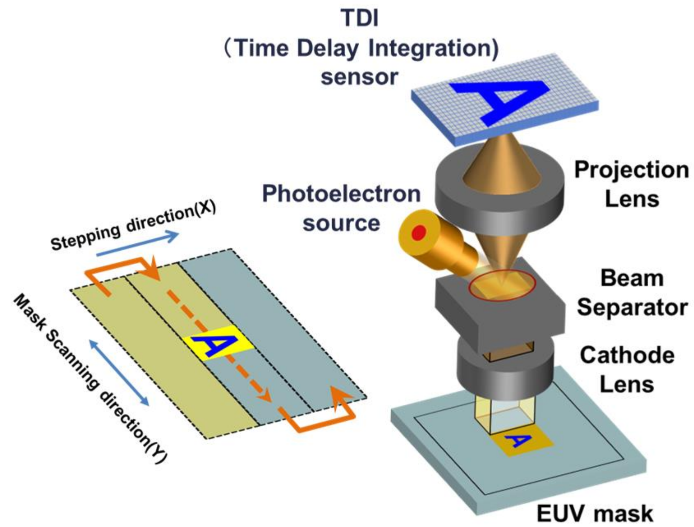
Pixel size dependent detection capability



16nm defect can be captured by 24nm pixel

- **8.6 hours full mask scan**

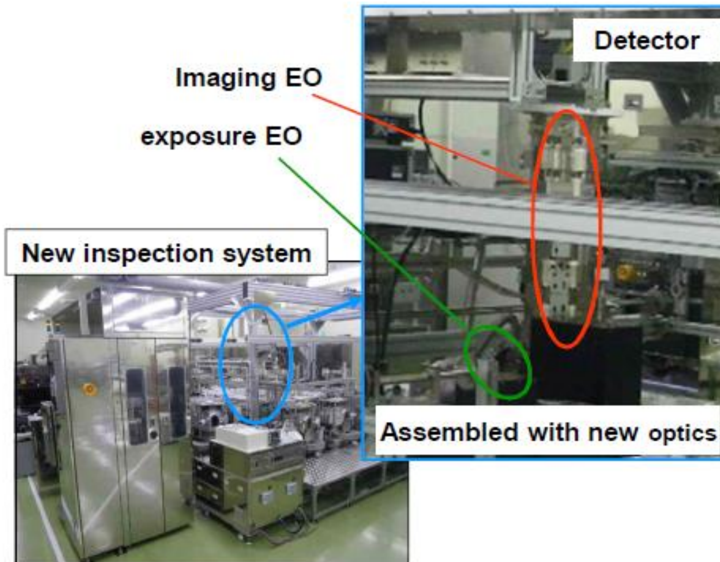
EIDEC PI program



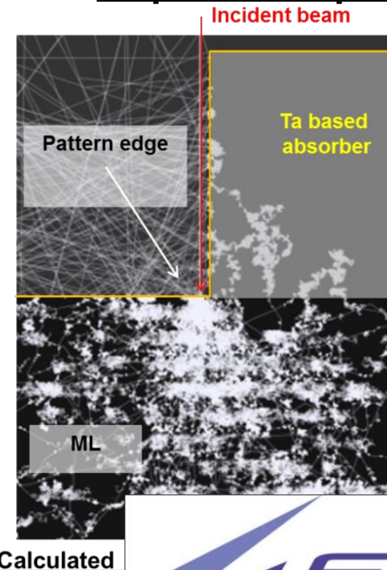
Concept of EIDEC PI tool with PEM

Defect size nm	28	22	16
Mask SEM Image Edge defect (Intrusion)			
Defect PEM Image			
Image difference (binary) and Inspection Image (superimposed)			

Inspection capability of EIDEC PI tool

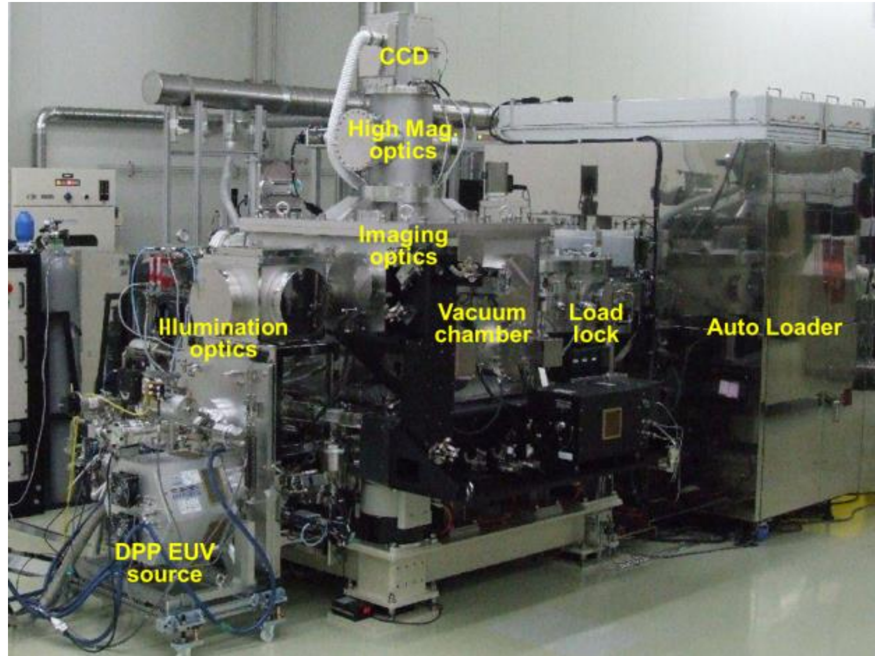


PEM PI tool installed by EIDEC and EBARA

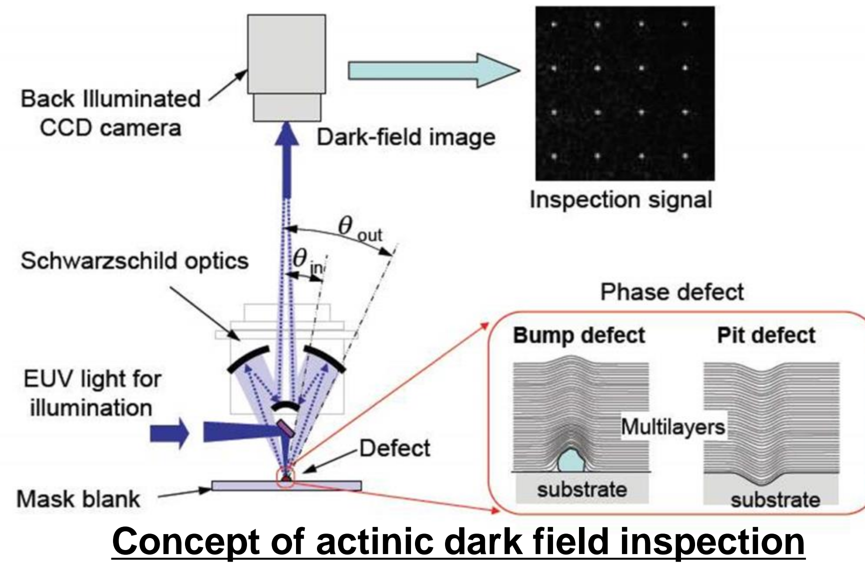


Another EIDEC activity on PI;
electron interaction analysis

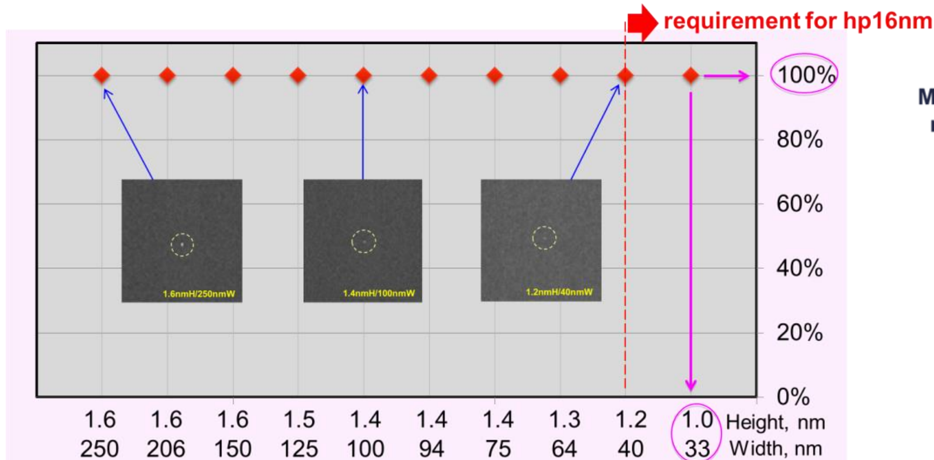
EIDEC BI program



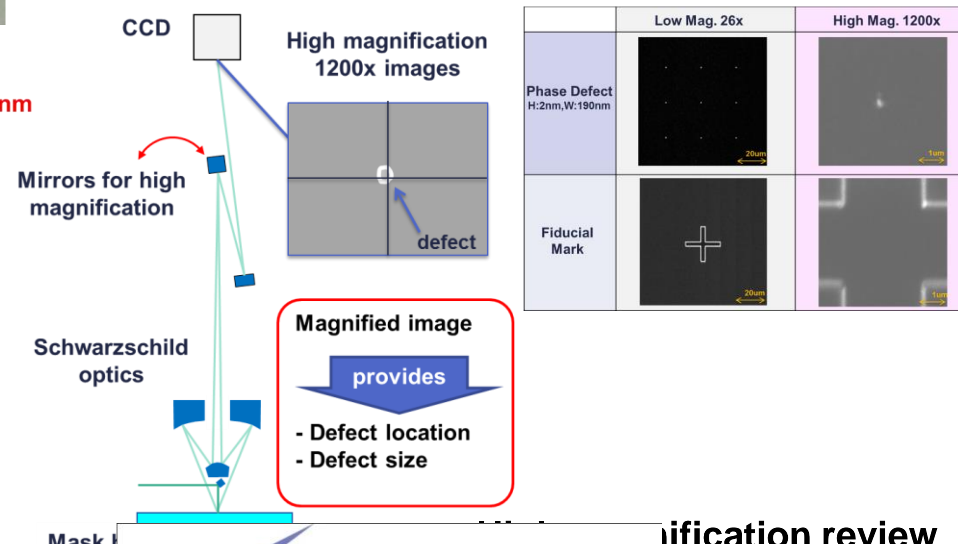
Installed ABI tool by EIDEC with Lasertec



Concept of actinic dark field inspection

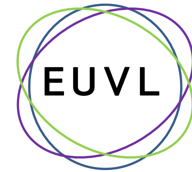


Verified detection capability for hp16nm



...ification review
...defect mitigation

Introduction: **Center for EUV Lithography**



NewSUBARU Synchrotron Radiation Facility

Reflectometer

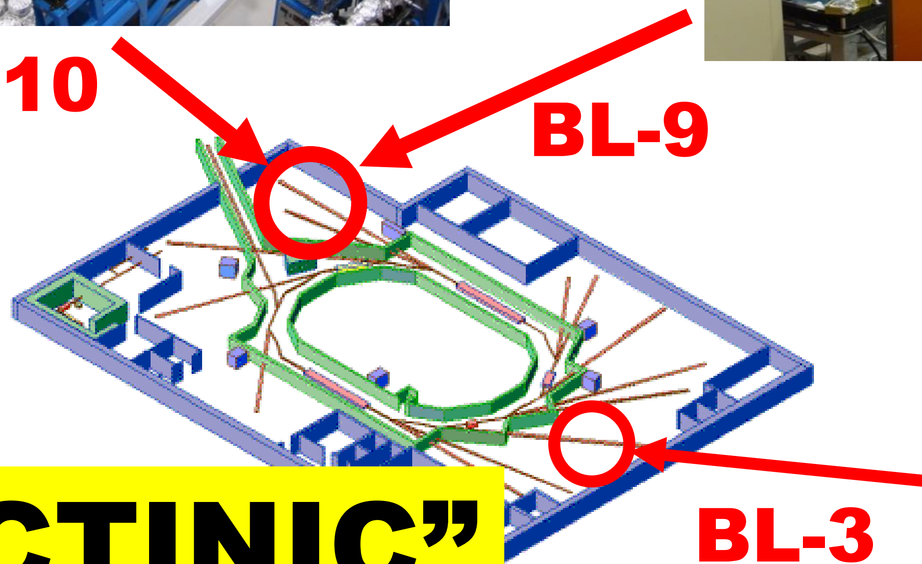
Resist & Mask

Interference Lithography &
Resist evaluation system

Resist

BL-10

BL-9



Microscopes (EUVM & CSM)

Mask

BL-3

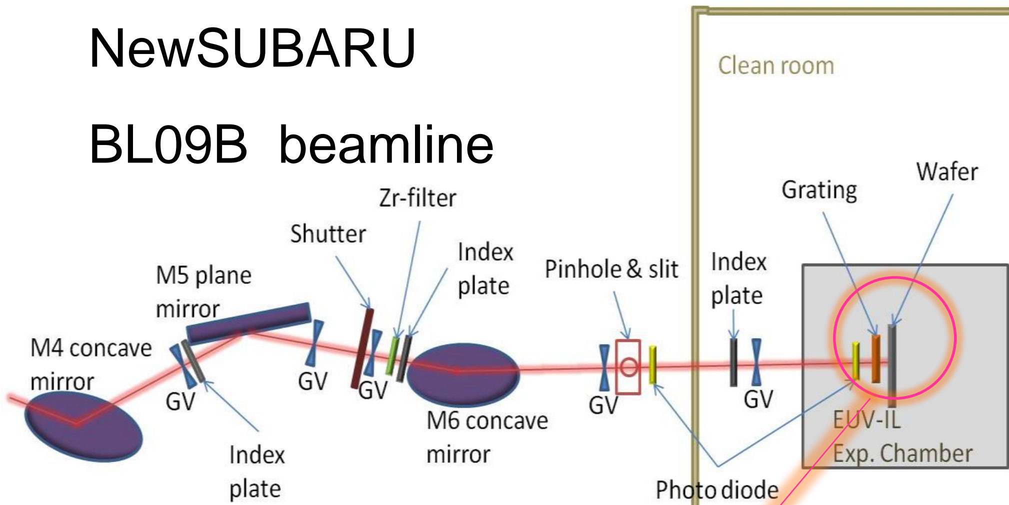
"ACTINIC"

Three Beamlines for EUVL

EUV Interference Lithography

NewSUBARU

BL09B beamline



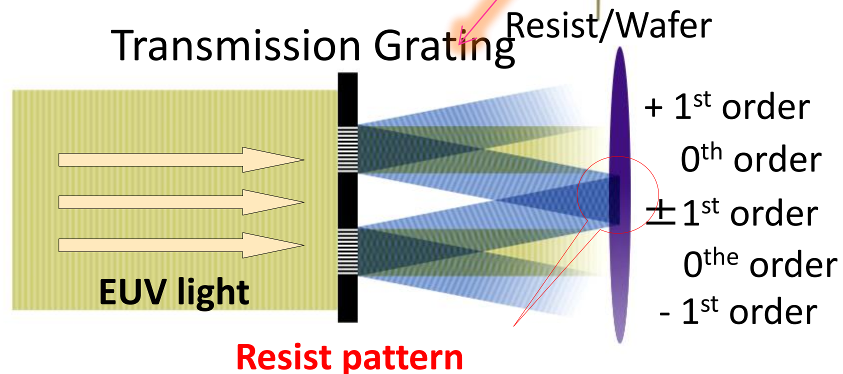
10^{-5} Pa

Exposure system

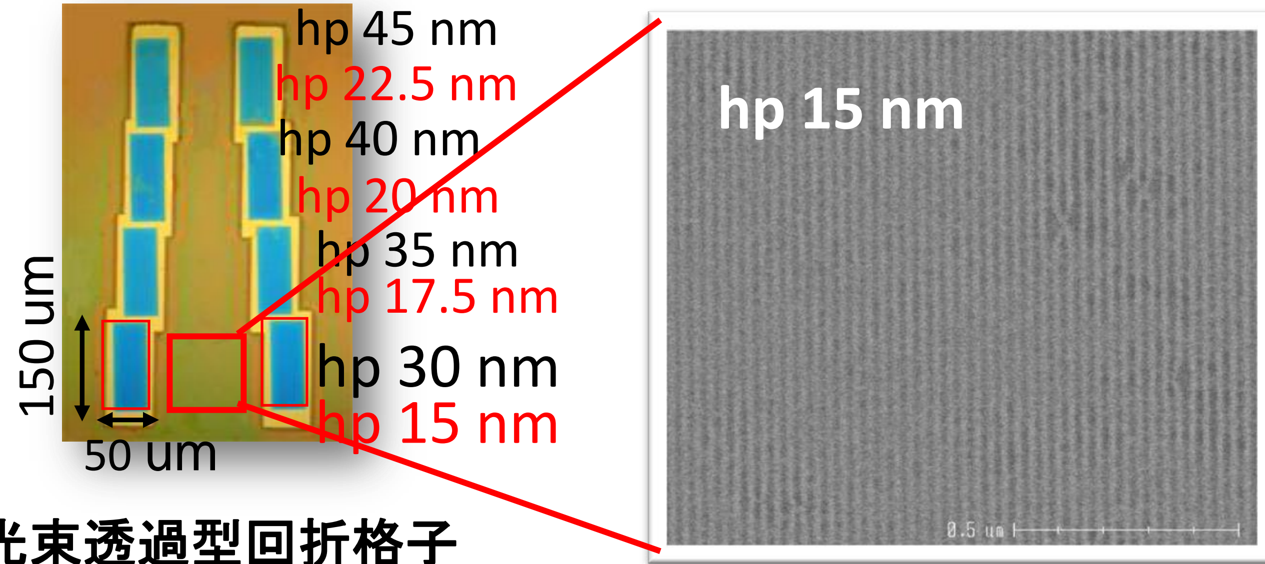
Cleanroom Class 100

Transmission Grating

Resist/Wafer

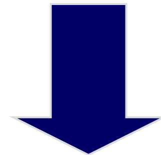


Development of new fabrication process

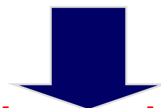


2光束透過型回折格子

Resolution of organic resist is 25 nm L/S.

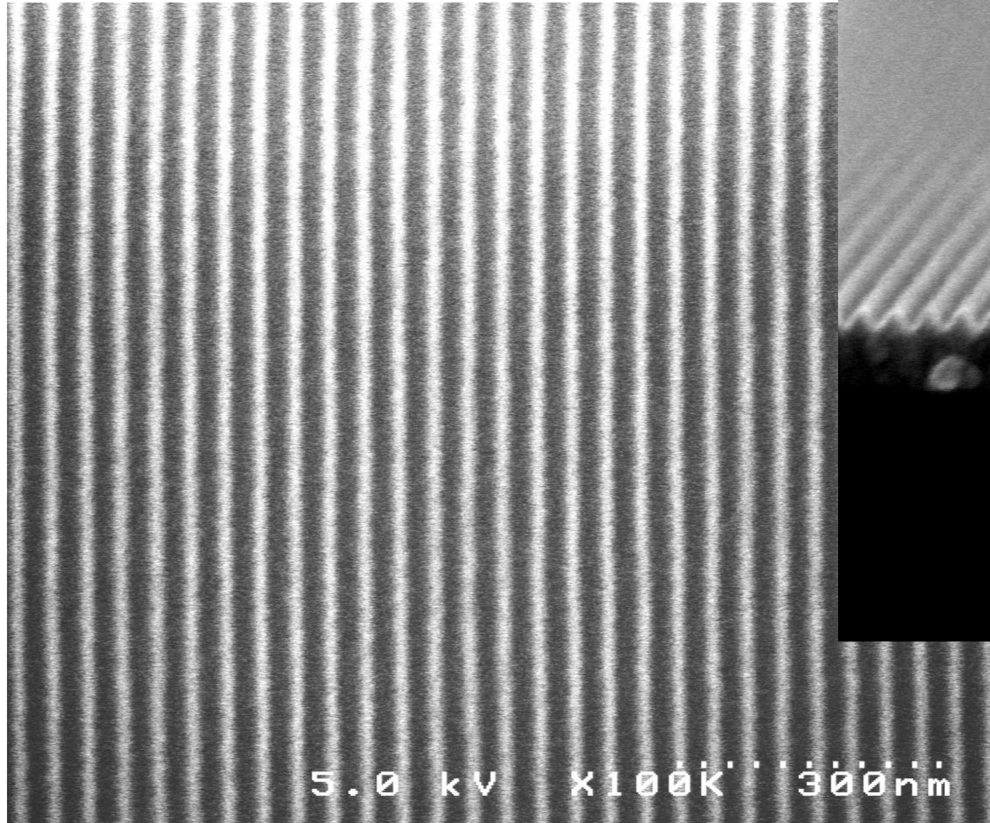


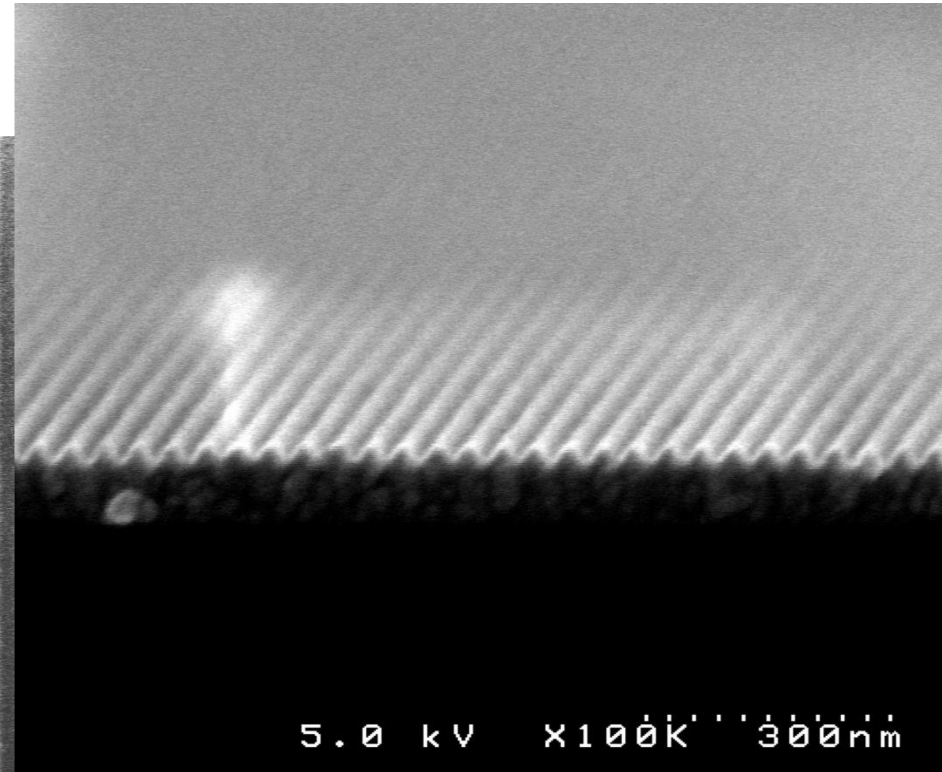
10-nm pattern fabrication requires the resist which resolves 20 nm.



The inorganic resist which has the resolution of less than 10 nm is examined.

Inorganic resist pattern on TaN





20 nm L/S pattern by EB

TaN pattern after dry-etching