

Update on SFET Optics Contamination Learning

- Analysis of carbon contamination -

Iwao Nishiyama



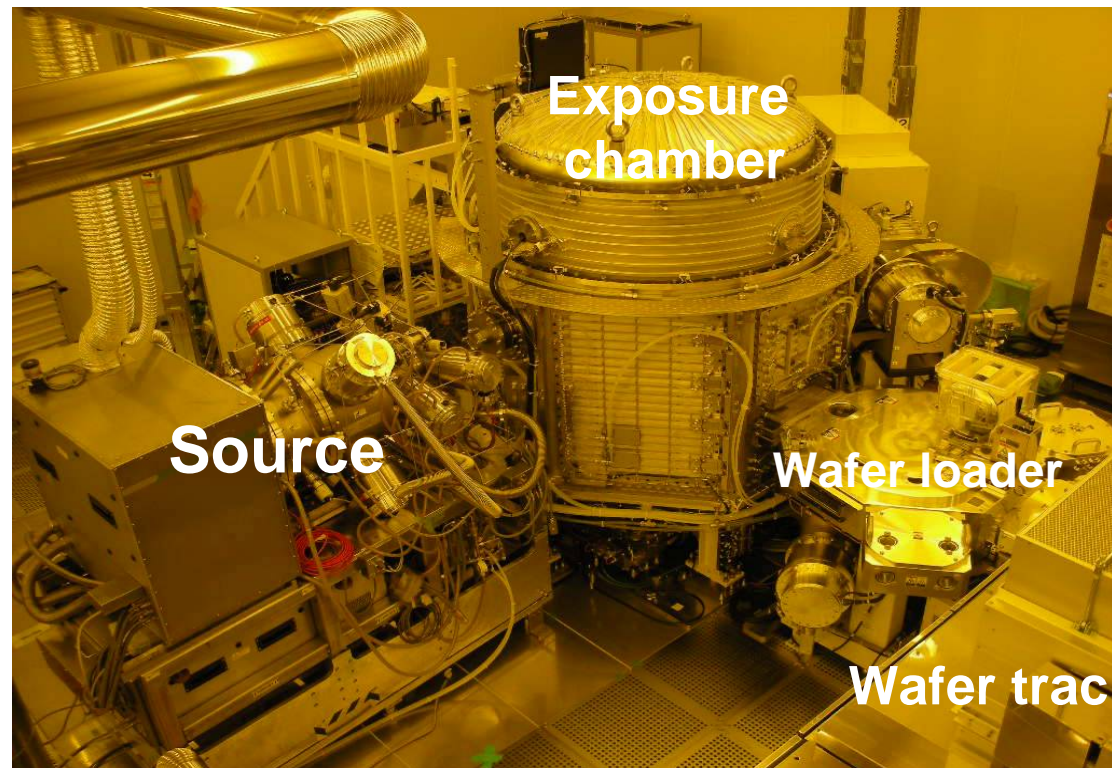
Semiconductor Leading Edge Technologies, Inc.

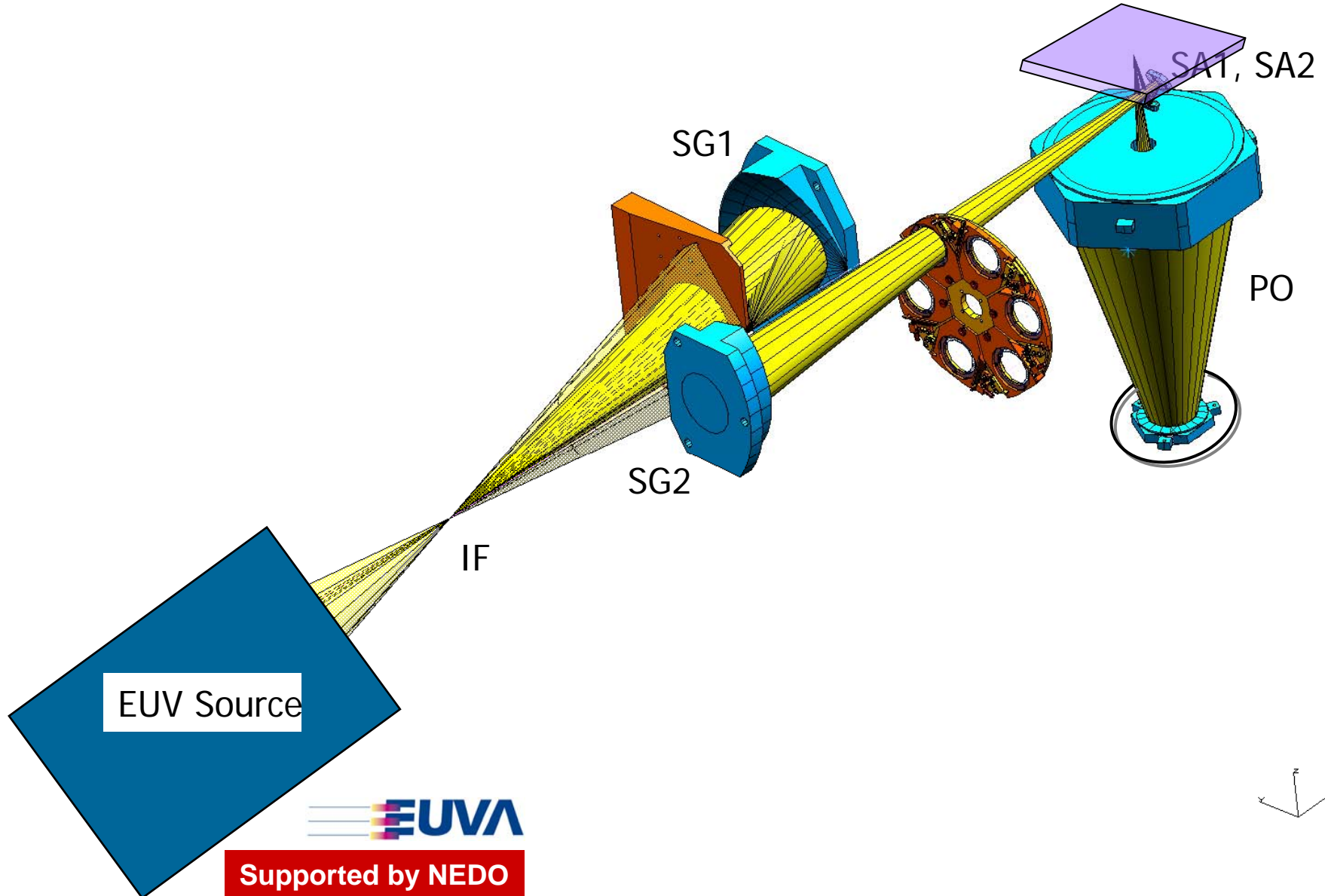
This work was supported by NEDO

Purposes

- ◆ Optimize mask structure
- ◆ Develop resist materials
- ◆ Evaluate optics & source lifetime

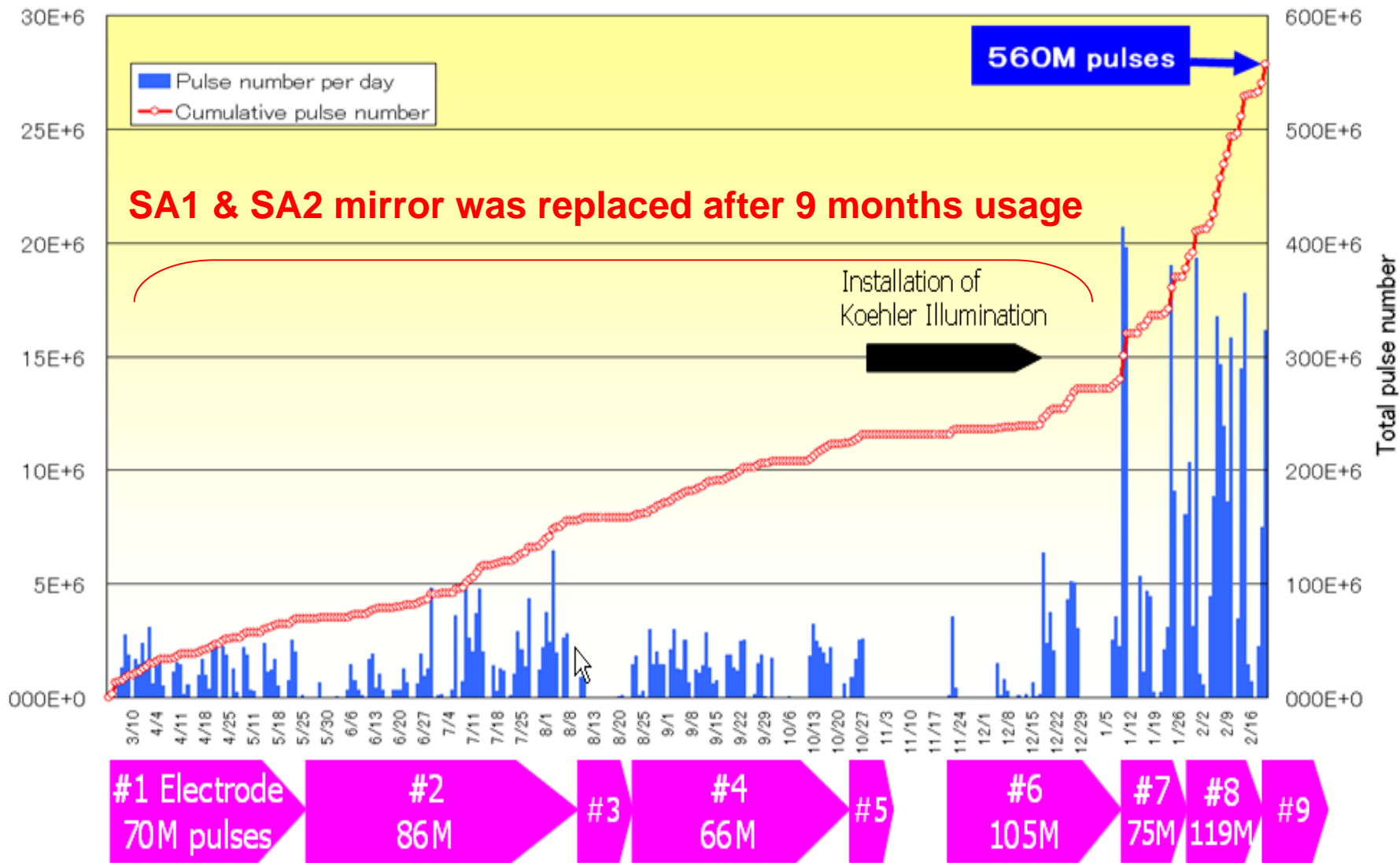
Items	Specification
NA	0.3
Field size	0.2 x 0.6 mm
Magnification	1/5
Wafer size	300mm



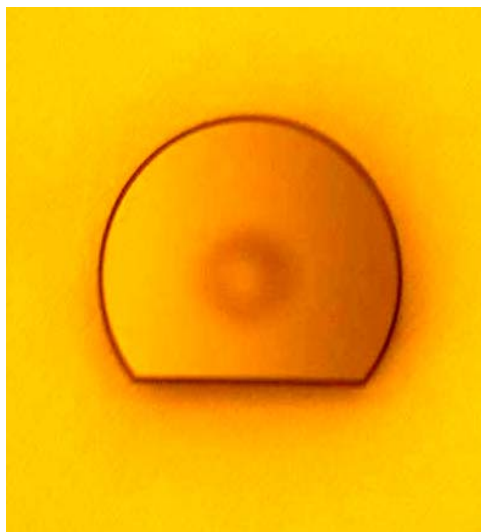


Supported by NEDO

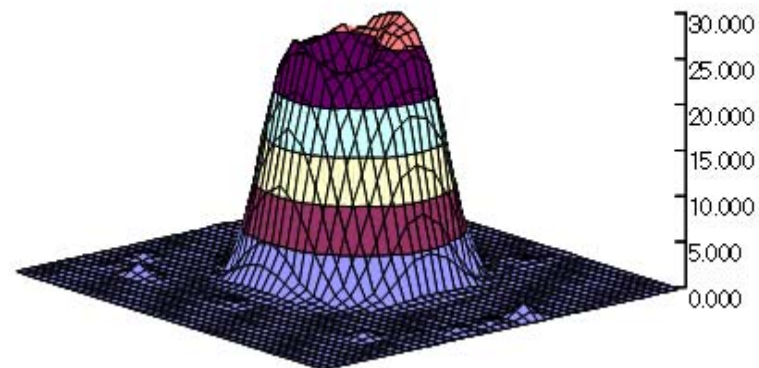




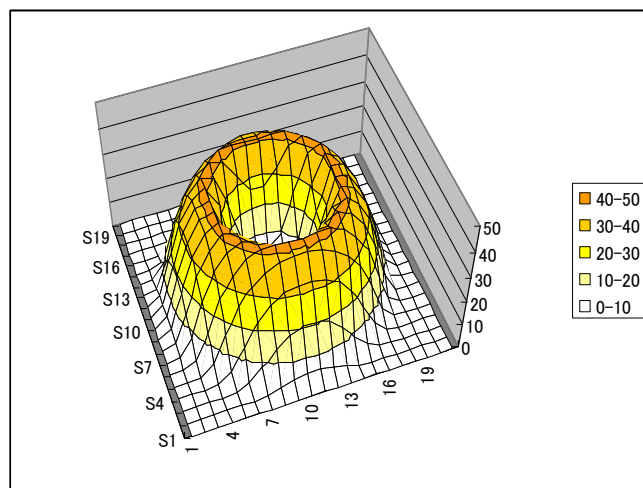
- ◆ Ellipsometry
- ◆ TEM (transmission electron microscopy)
- ◆ Micro beam GIXR (Grazing Incidence X-ray Reflectometry)
- ◆ XPS (X ray photoelectron spectroscopy)
- ◆ Raman spectroscopy
- ◆ EELS (electron energy-loss spectroscopy)
- ◆ RBS (Rutherford backscattering spectroscopy)
- ◆ ERDA (Elastic Recoil Detection Analysis)
- ◆ TOF-SIMS (Secondary ion-microprobe mass spectroscopy)
- ◆ ATR-FTIR (attenuated total reflectance Fourier transform infrared spectroscopy)



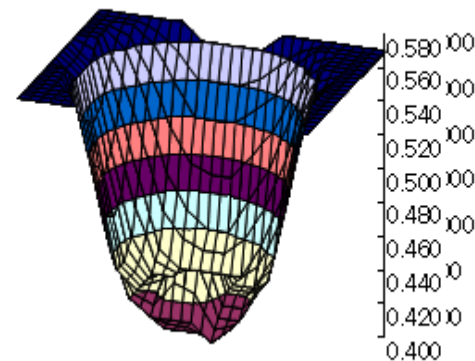
Film thickness



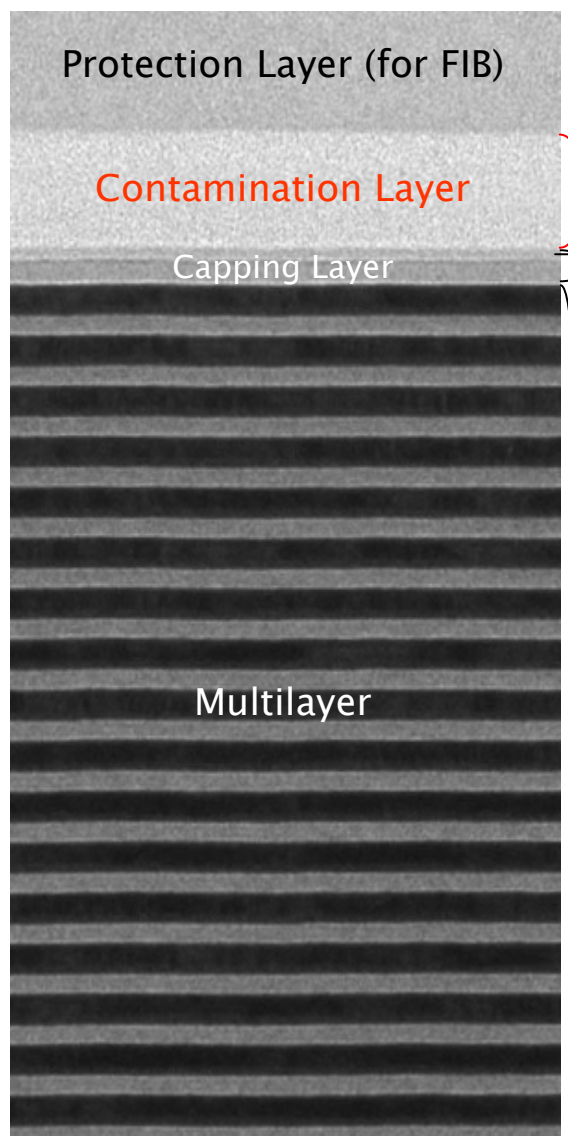
Estimated intensity distribution



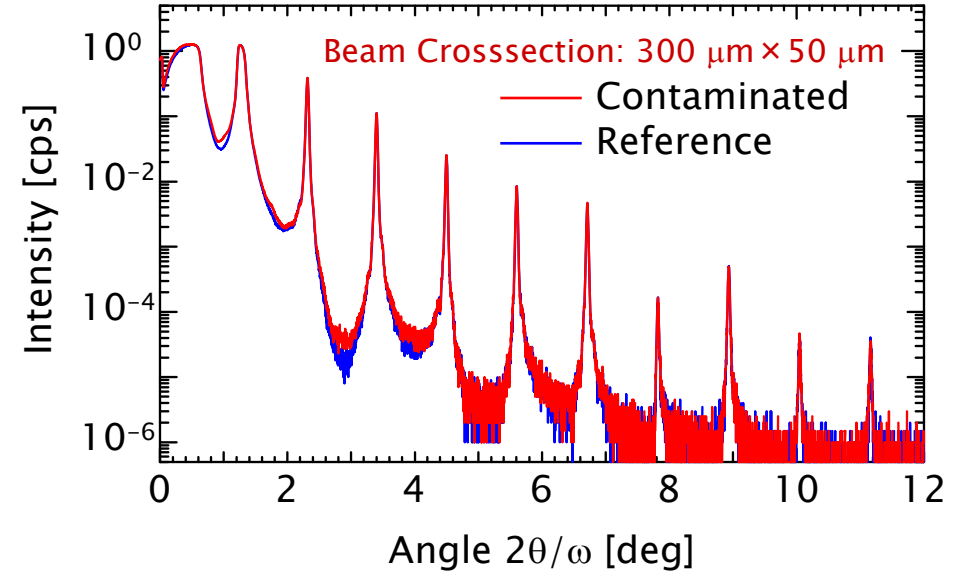
Reflectivity loss



■ Crossectional TEM Image



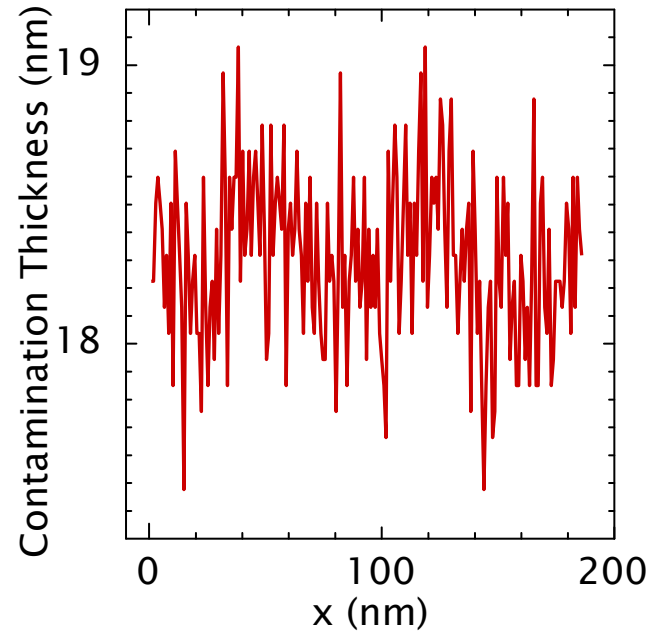
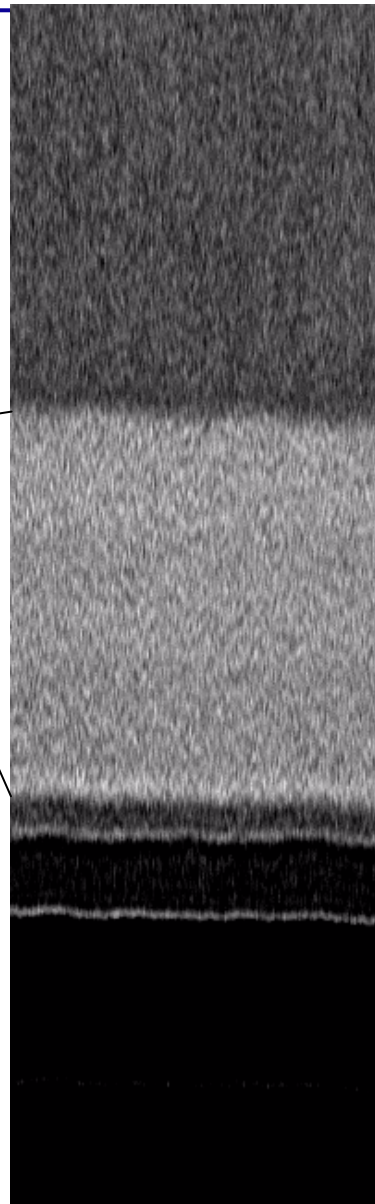
■ Measured Spectra



■ Results of Simulation Fitting

	Density (g/cm ³)	Thickness (nm)	Roughness (nm)
C	1.35	20.60	1.60
SiO ₂	2.20	2.787	0.82
Si	2.33	5.827	0.30
MoSi	4.51	0.145	7.934 × 50
Mo	10.20	3.162	
MoSi	9.74	0.130	
Si	2.33	4.497	0.28
SiO ₂	2.20	-	0.20

@Most Thick Region



Average Thickness (nm)	18.3
Standard Diviation (nm)	0.30

Weight Density: **1.27 g/cm³**
(combination with RBS)

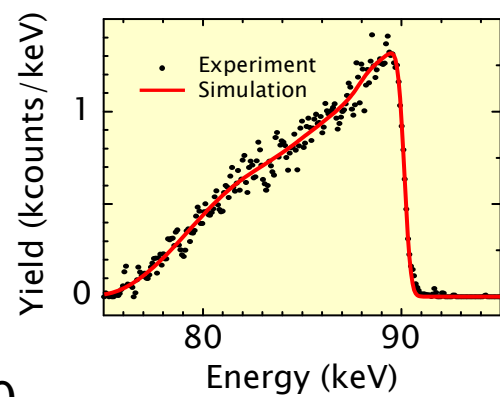
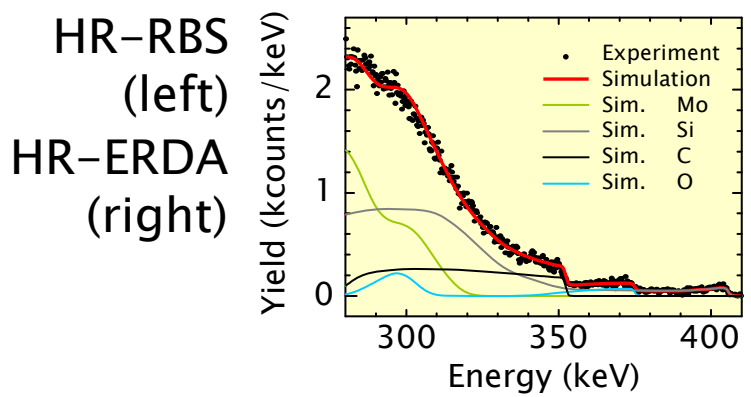
1/10 Compression in horizontal axis →

214 data points = 20 nm (virtical)

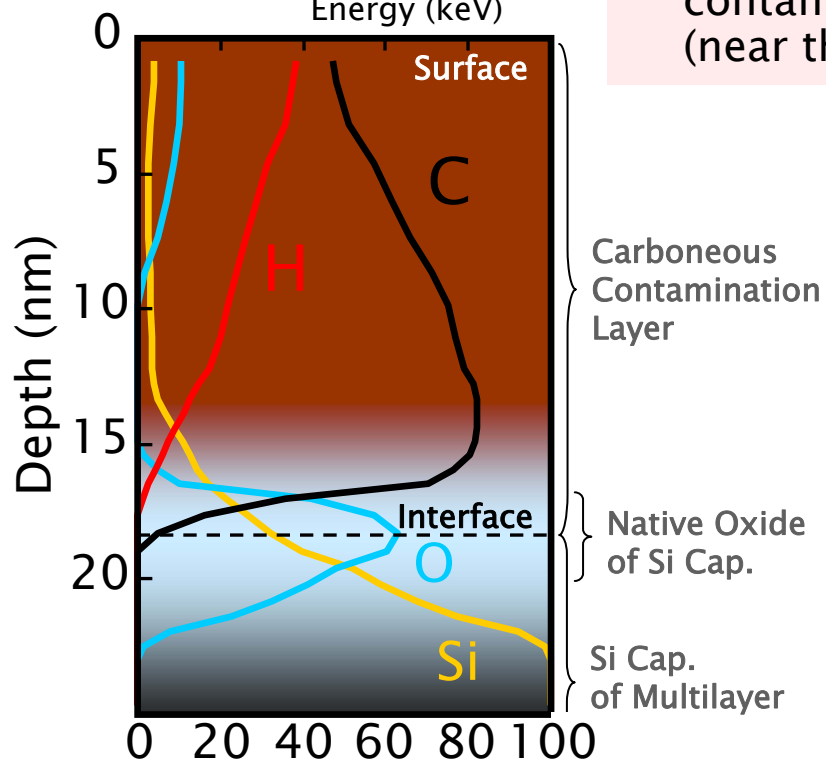
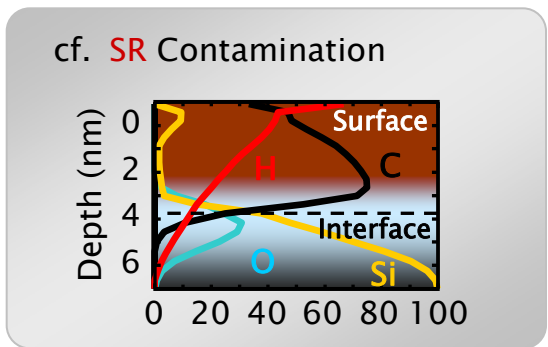
214 data points = 200 nm

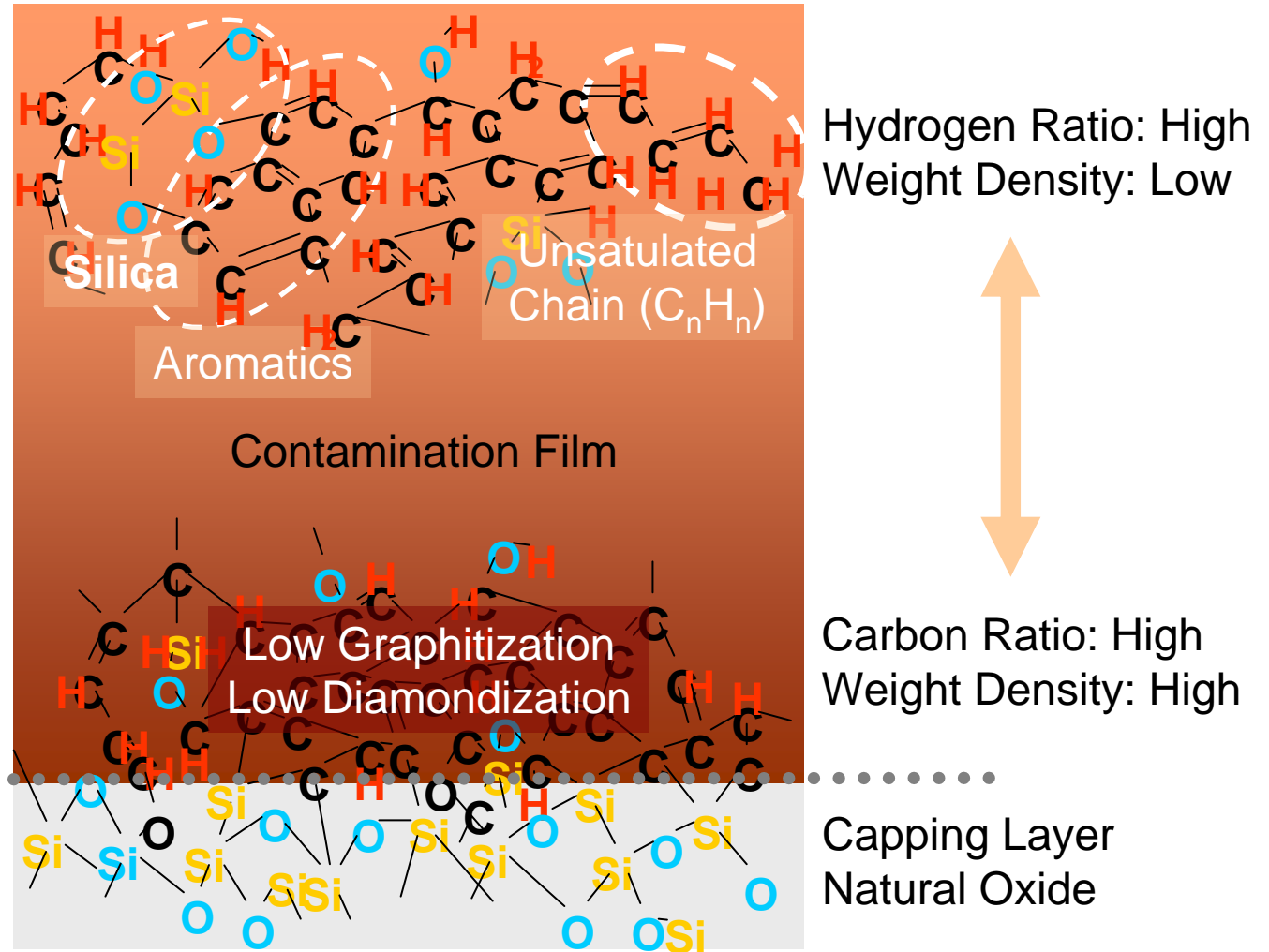
(horizontal)

Element Analysis by Scattering Simulation Fitting



- Contamination film contains much **H**.
- Ratio of **C/H** increases with the depth.
- **Si** is detected within contamination.
- **O** is detected within contamination (near the surface).





- A real contamination of SFET mirror and a model contamination deposited with SR have been characterized.
- The thickness and weight density of contamination film was:
 - 18.3 nm and 1.27 g/cm³ for SFET
 - 5.68 nm and 1.87 g/cm³ for SR
- Elemental composition (ratio) of both contamination films are similar and they consist of:
 - Mainly Carbon and Hydrogen
 - Percent of Oxygen and Silicon (Silicon seems inorganic)
 - Trace of Fluorine
- Fraction of C/H increases in deeper region.
- Degrees of carbonization are low and SFET contamination preserves polymer character in surface region.
- Reflectivity distribution is explainable by film thickness distribution (but decline seems somewhat larger than simulation calculation).