Beneficial Photoacid Generator for Chemically Amplified Resist in EUVL

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Outline

1. Introduction

2. The detail of resist evaluation system

3. PAG anion effect in a CA positive-tone resist

4. Summary

EUV Resist issue

Specification of 32 nm node

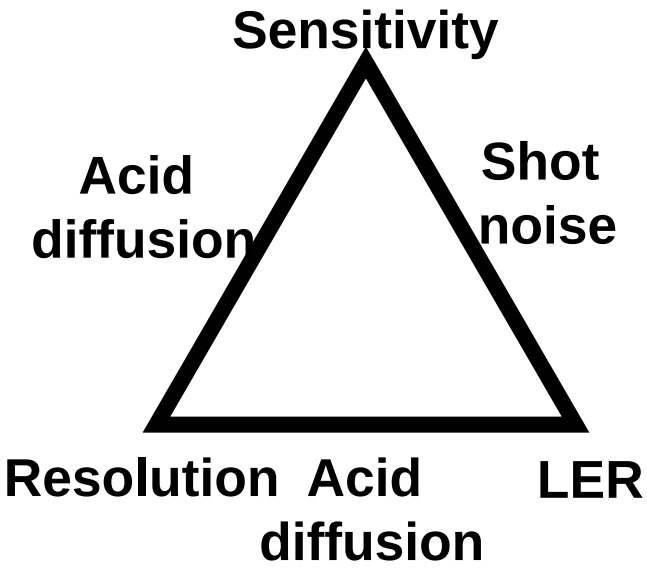
Resolution（Gate) 15 nm

Dense pattern　50 nm HP

Sensitivity ≦ 2～5 mJ/cm^2

LER ≦ 2 nm (3σ)

Total Outgas ≦ 1×10^{-6} Pa



Reduce affection of shot noise
⇒Increase acid generation quantum efficiency

→ Beneficial PAG for EUV resist

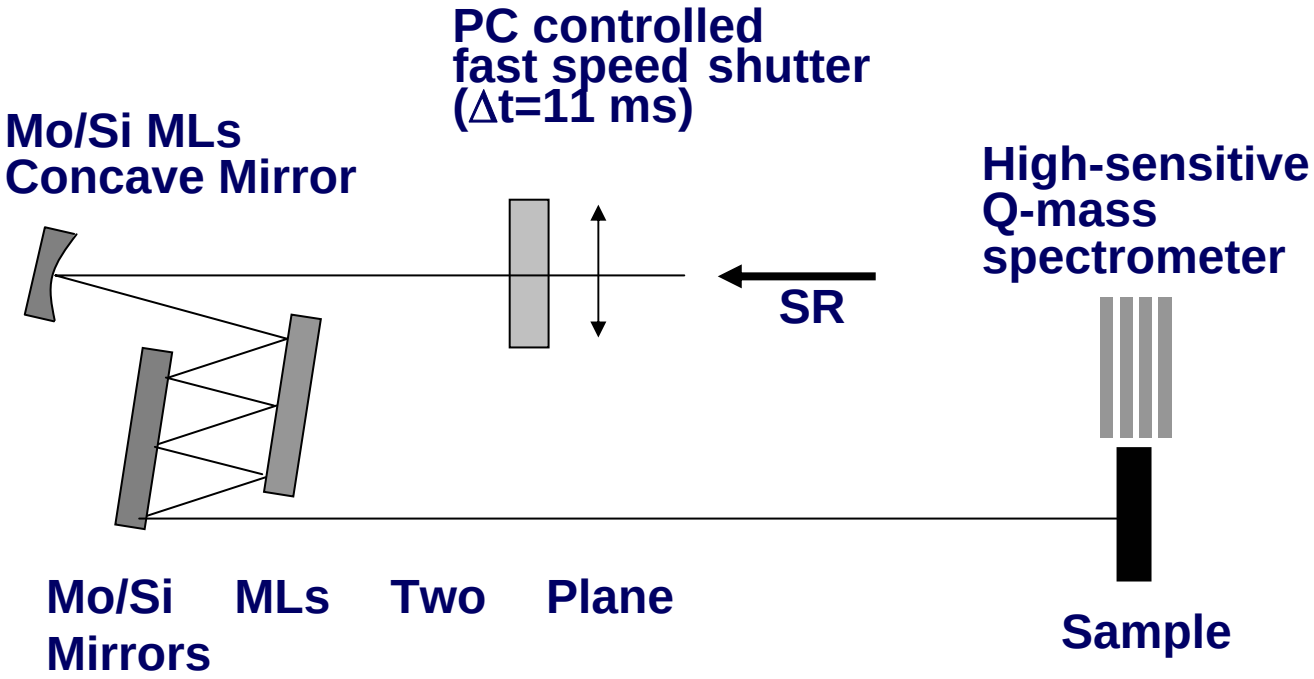
Setup of novel resist evaluation system

1) Measurements of sensitivity
2) Outgas characteristics
3) Internal chemical behavior analysis

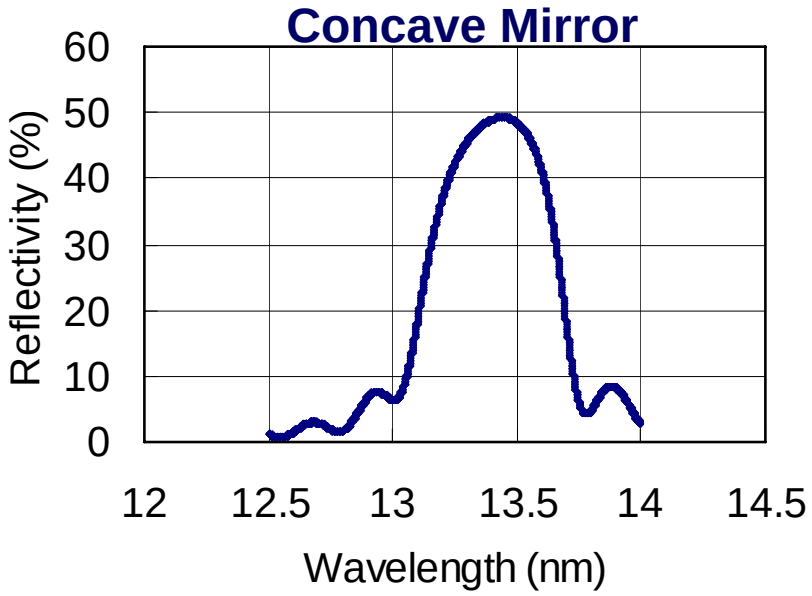
Simulating six-mirror optics

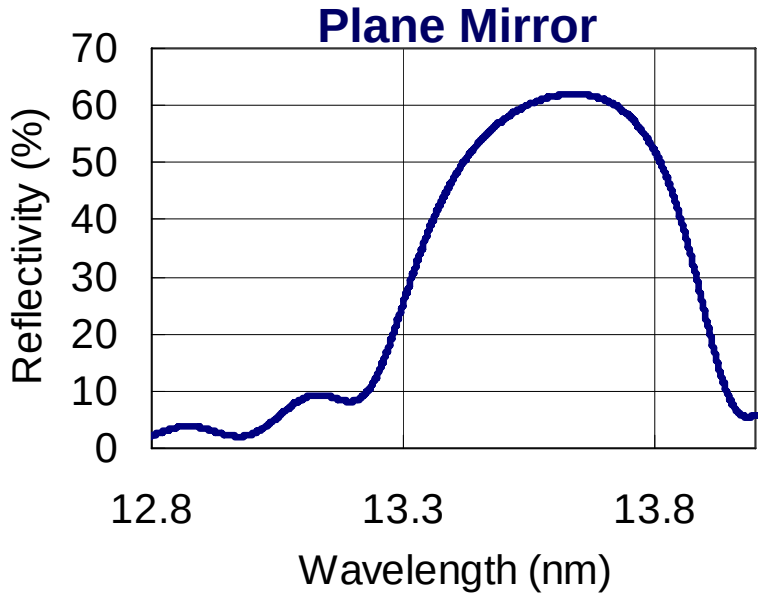
↓

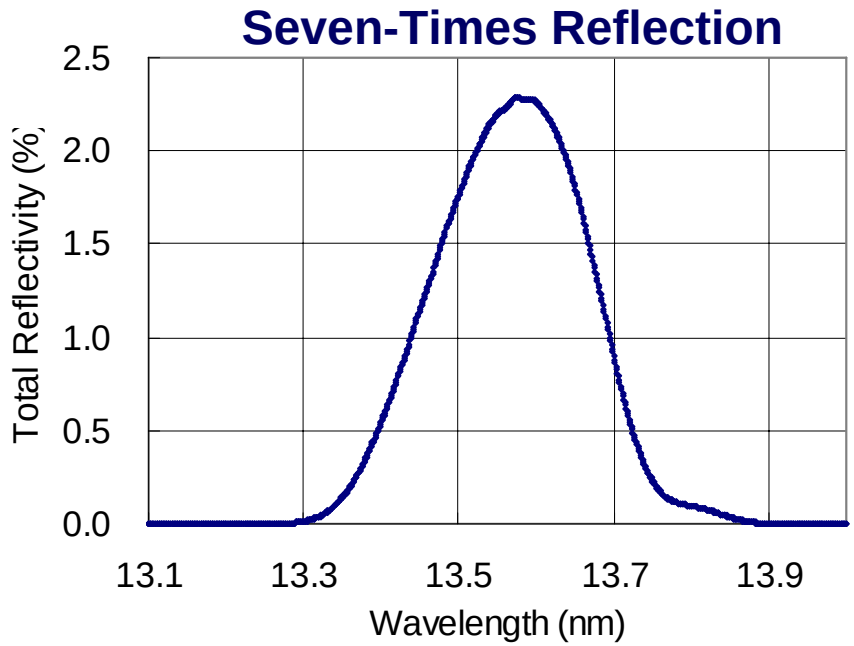
Practical exposure spectrum



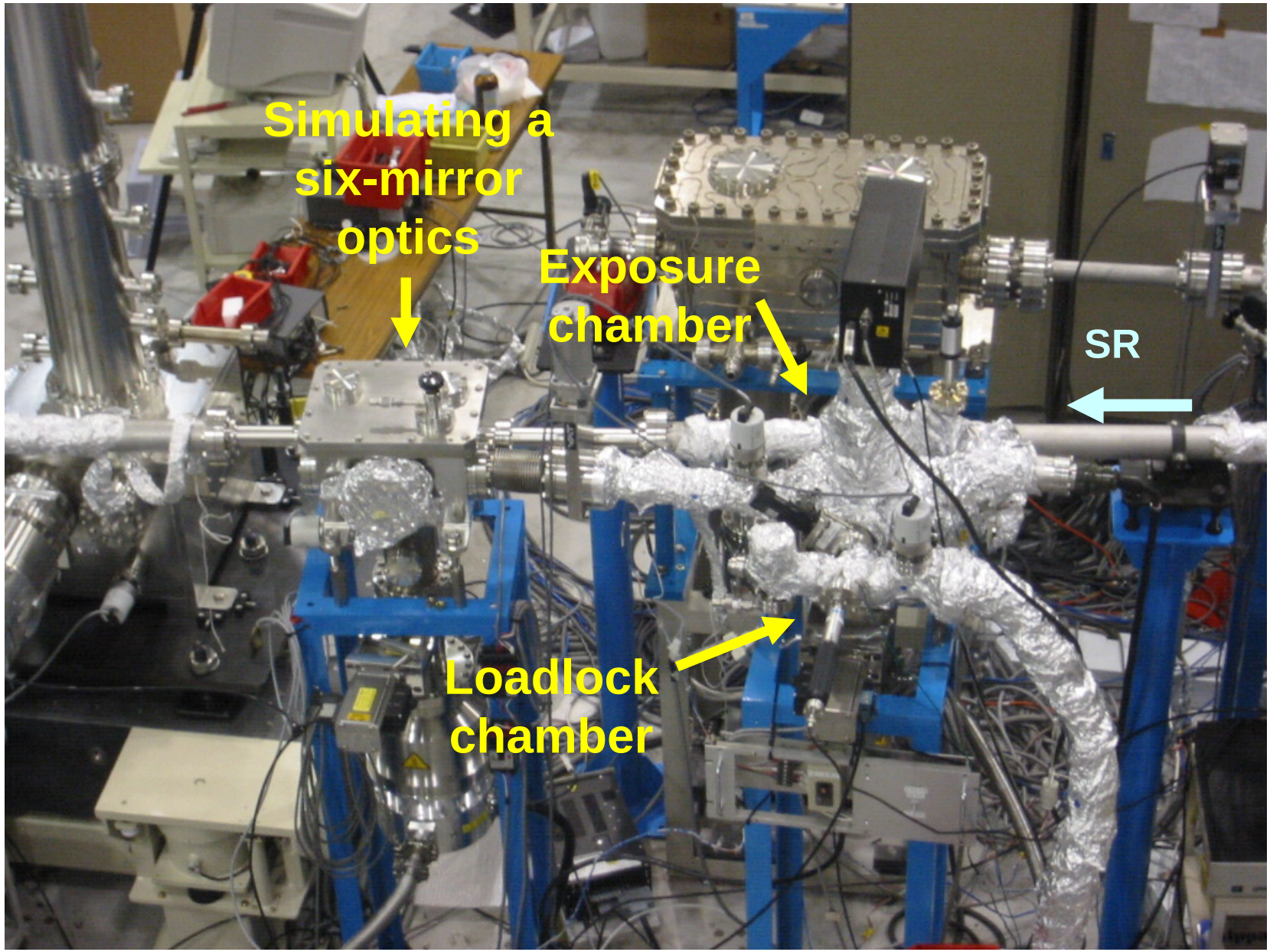
Reflectivities spectra of Mo/Si MLs







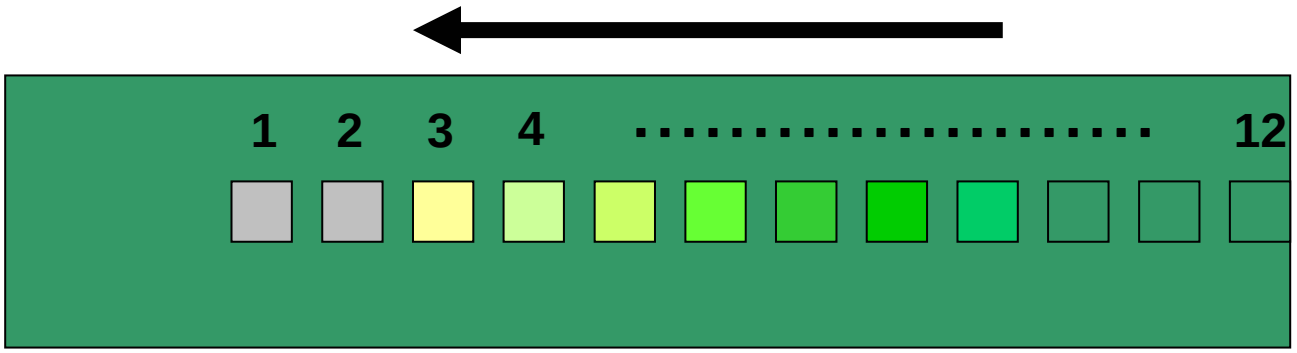
Setup of resist evaluation system



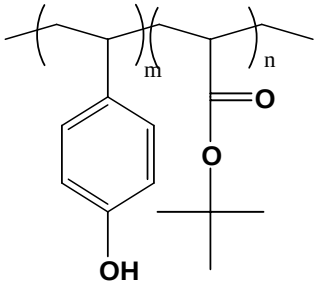
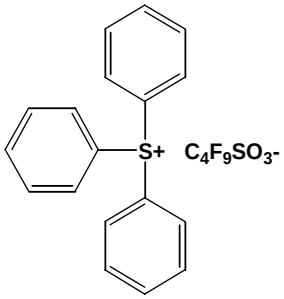
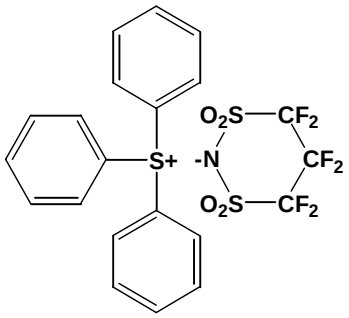
Sample exposure

Loadlock chamber

Pumping time	**1 hour to 10^{-5} Pa**
Sample chamber	**2×10^{-6} Pa**
Sample size	**85 mm × 18 mm**
Exposure area	**4 mm × 4 mm / shot**
Total shots	**12 shots/sample**



Resist samples employed in the experiment of PAG effect

Sample	Resist A	Resist B	Resist C
Resin	 poly (vinylphenol-co-tert butylacrylate)		
PAG	None	TPS-PFBS (10 wt% Ref.) 	TPS-Imine 
Solvent	propylene glycol monomethylether acetate (PGMEA)		

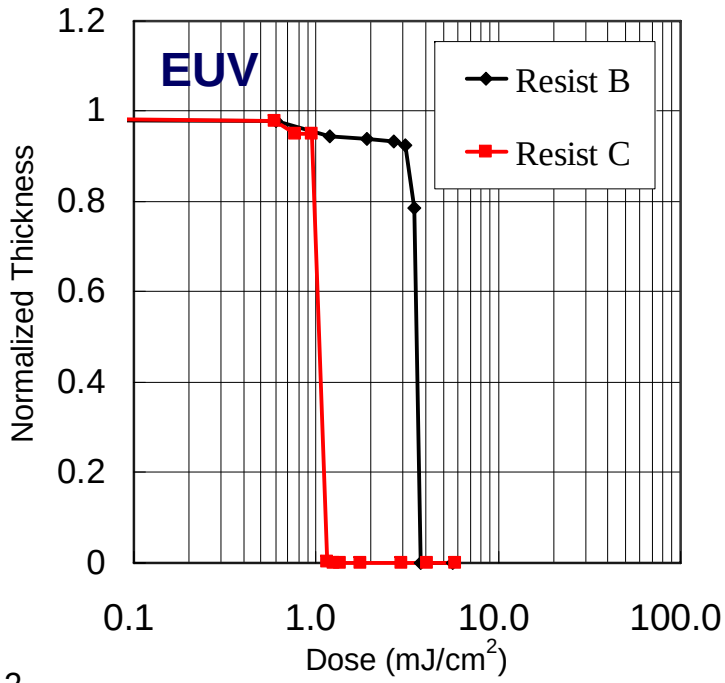
Experimental Conditions

- **Substrate : Si Wafer**
- **Film Thickness : 100nm**
- **PAB : 130℃ 90 s**
- **Exposure : λ = 13.5nm**

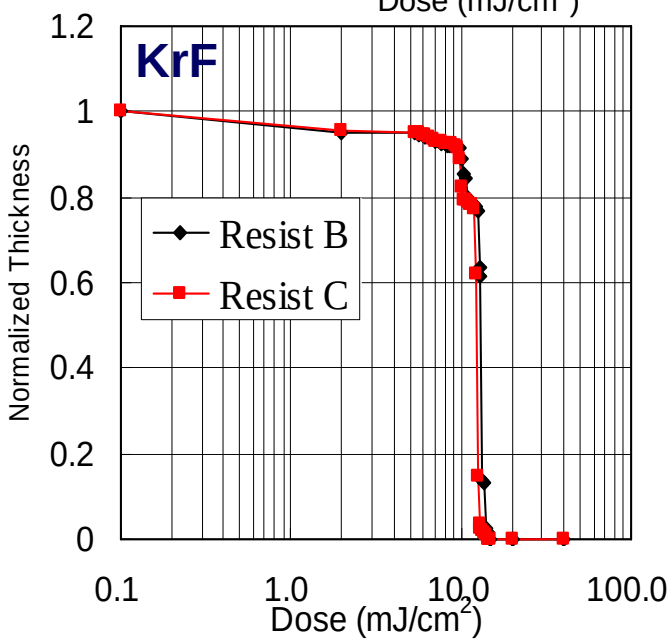
  200mA (0.33 mW/cm^2)

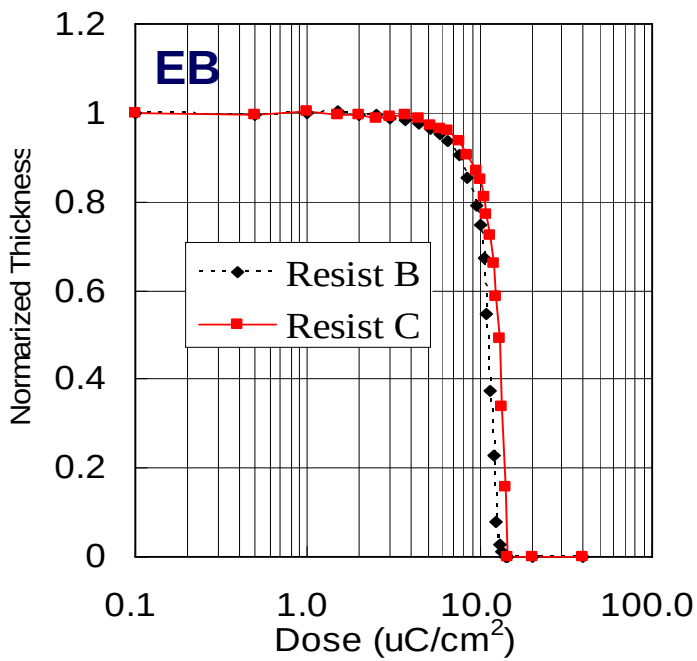
  20 mJ/cm^2 (@60 s exposure time)
- **PEB : 110℃ 90s**
- **Dev. : TMAH 2.38% 30s**

Eth difference under between EUV, KrF, and EB exposures



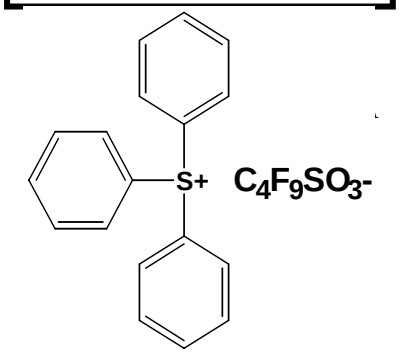
Sample	Sensitivity
Resist B	3.8 mJ/cm^2
Resist C	1.1 mJ/cm^2



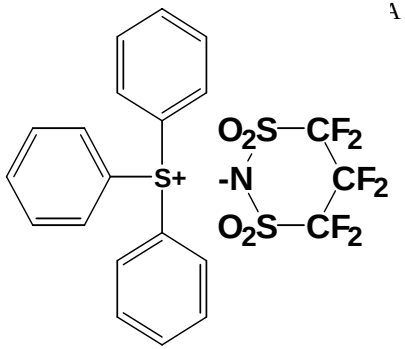


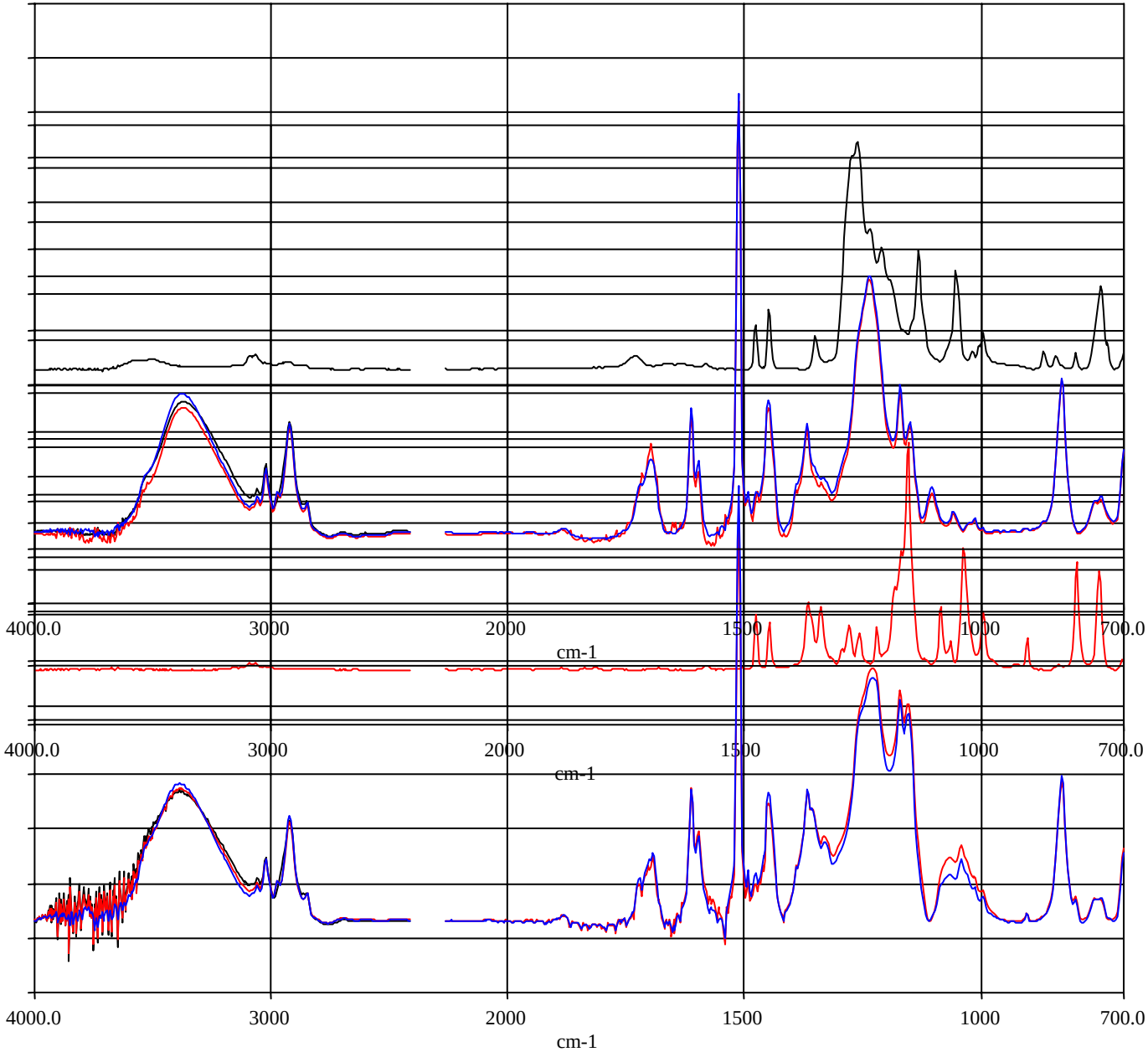
FT-IR measurement results of Resists B and C

Resist B



Resist C





Time dependency of outgassing species from Resist B

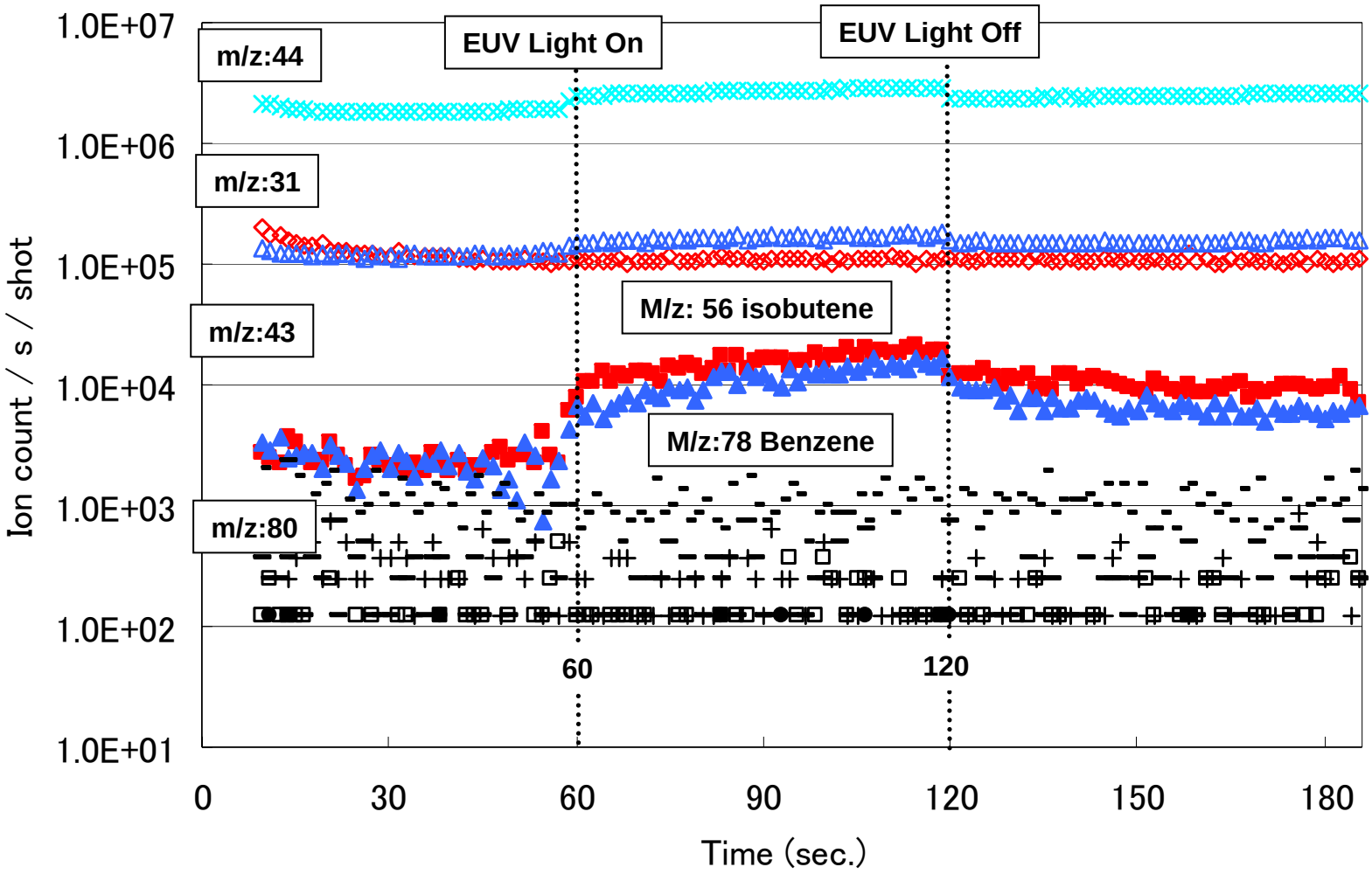
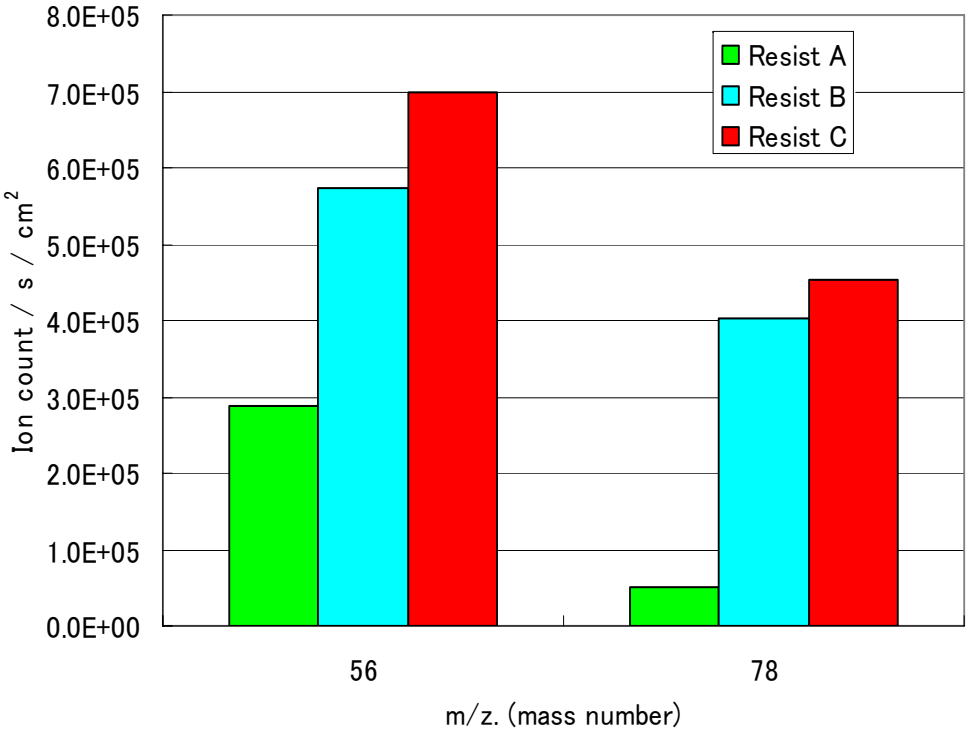


Photo decomposition reaction of cation of PAG in Resists B and C

m/z = 56
(isobutene)

m/z = 78
(benzene)



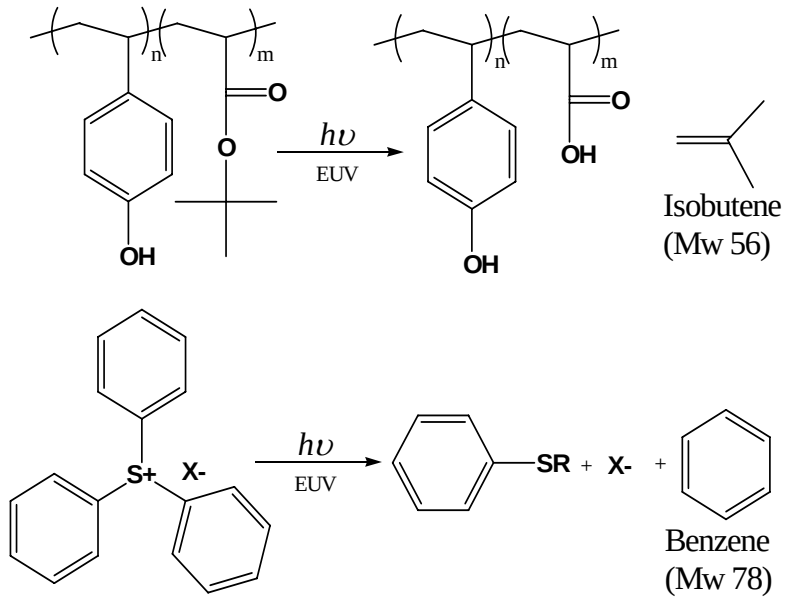
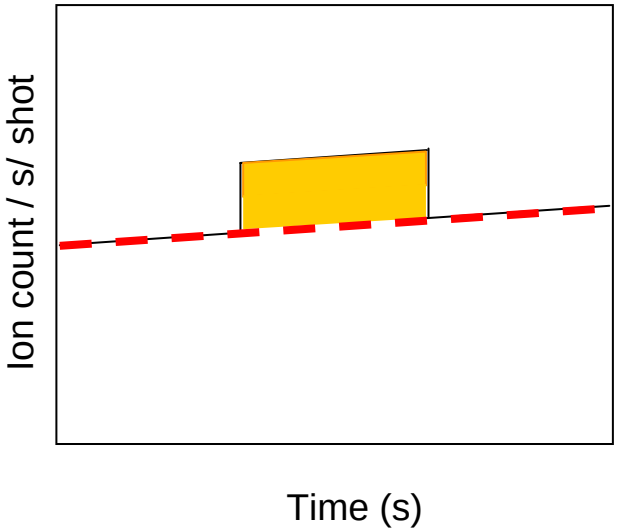
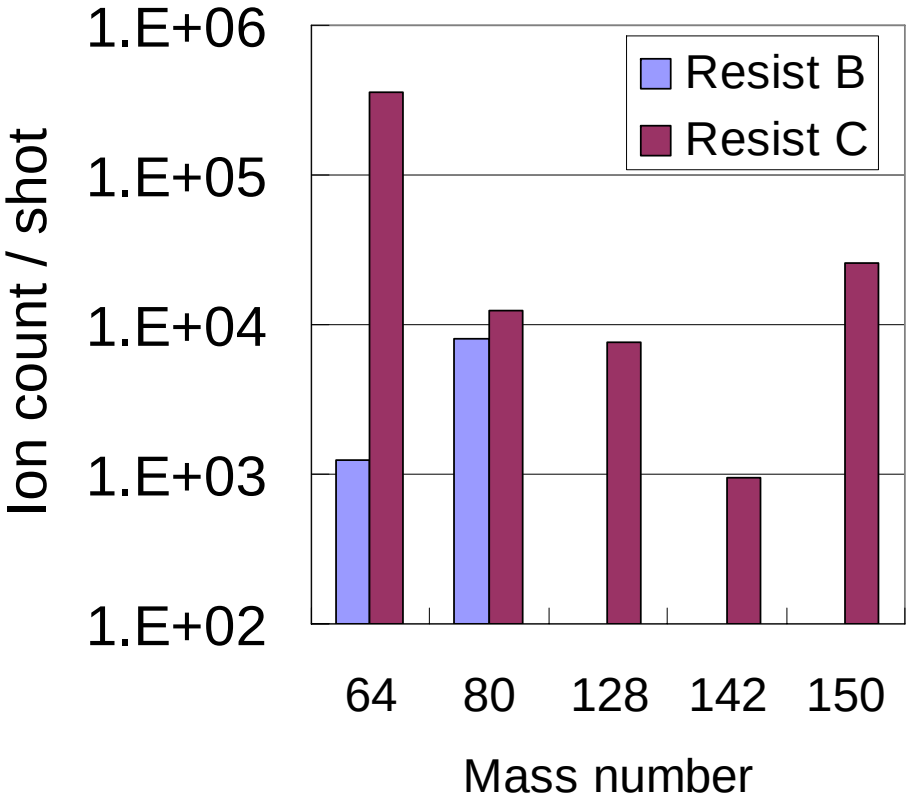
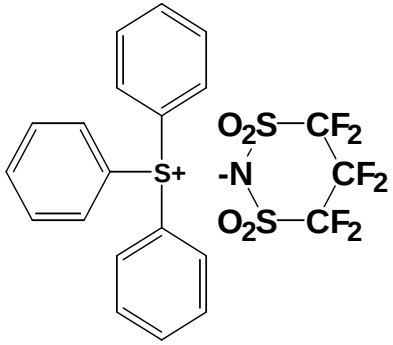


Photo Decomposition Species of Anion of PAG





m/z	species
64	SO_2
80	SO_3
128	CF_2SO_2N
142	SO_2-N-SO_2



Summary

1) Using resist evalutation system which can simulate 6-mirror imaging optics, resist sensitivity and outgassing characteristics of CAR were studied.

2) We found that TPS-Imidate employed as a photo acid generator is more sensitive than TPS-PFBS under EUV exposure.

3) As for resist C which contains TPS-Imidate, the amount of isobutene and benzene were larger than that of resist B.

4) As for resist C, photodecomposition species from PAG anion under EUV exposure was measured. This results satisfied the FT-IR measurement data.

5) It is consider that high sensitivity is own to photodecomposition reaction of an anion of TPS-Imidate.

6) Anion decomposition mechanism under EUV is useful to design PAG which can generate high yield of acid.

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