EIDEC Outgas Testing Update

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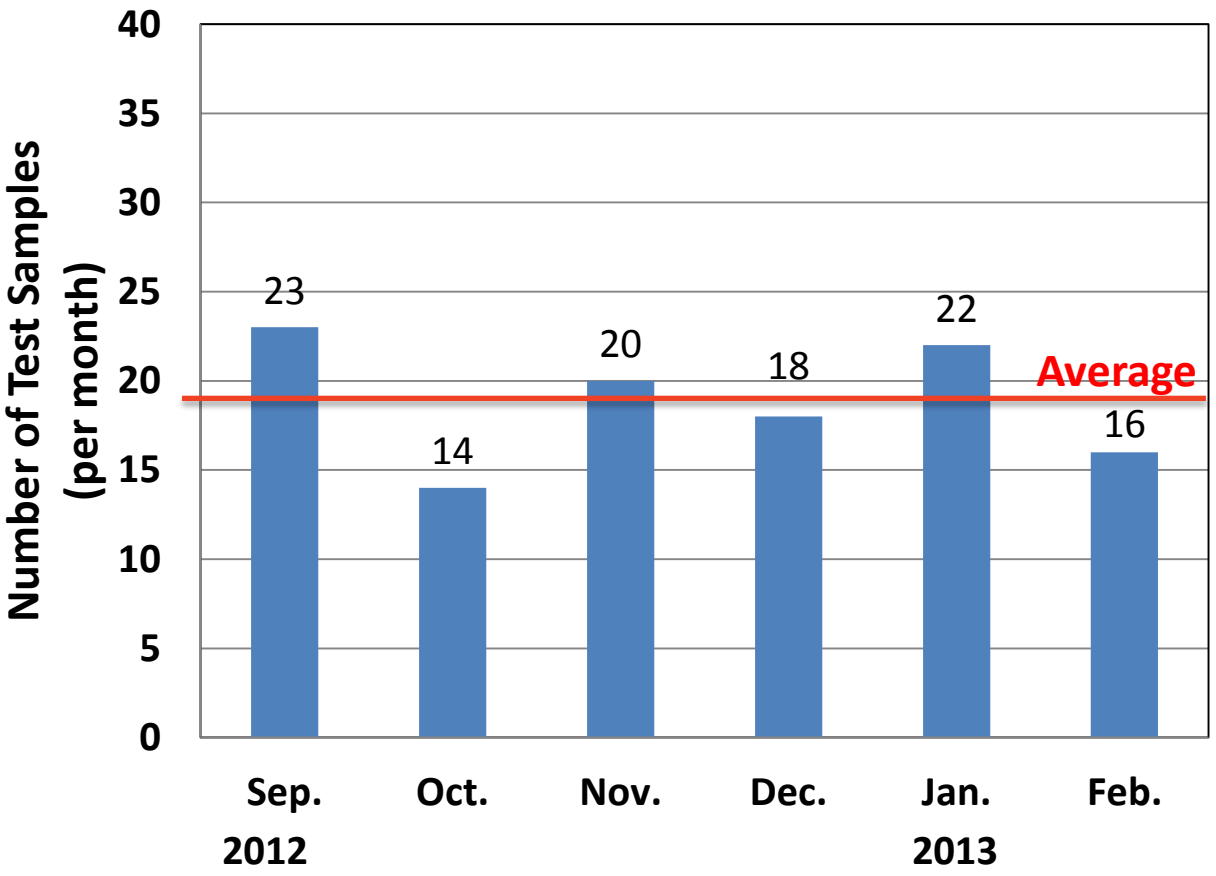
EUVL Infrastructure Development Center, Inc. (EIDEC)

Outline

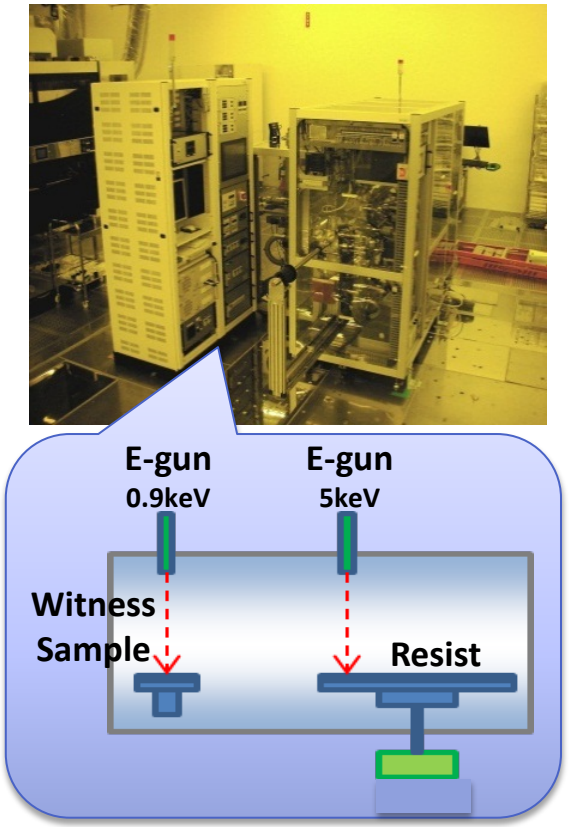
1. Current Status of Resist Outgas Qualification System
2. Toward Reduction of Outgas Test Samples
3. Fundamental Study on Non-cleanable Components
4. Summary

Number of Test Samples



EUVOM-9000 (LTJ)

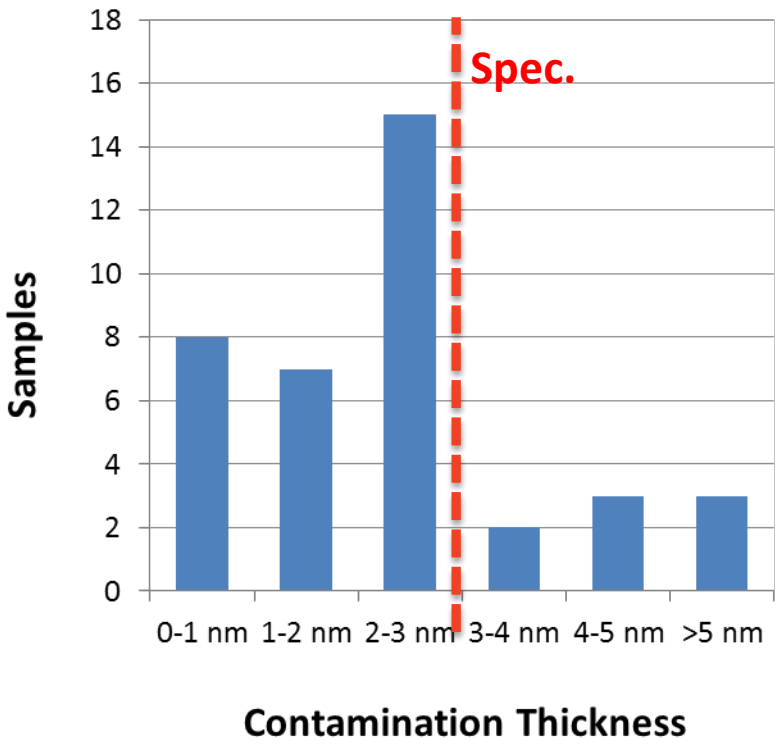
E-gun based Qualification Tool



- 113 samples in sum total were tested by Feb. 22th 2013.
  60 samples from the total are customer samples.
- 30~40 samples per month throughput is estimated in 2Q 2013.

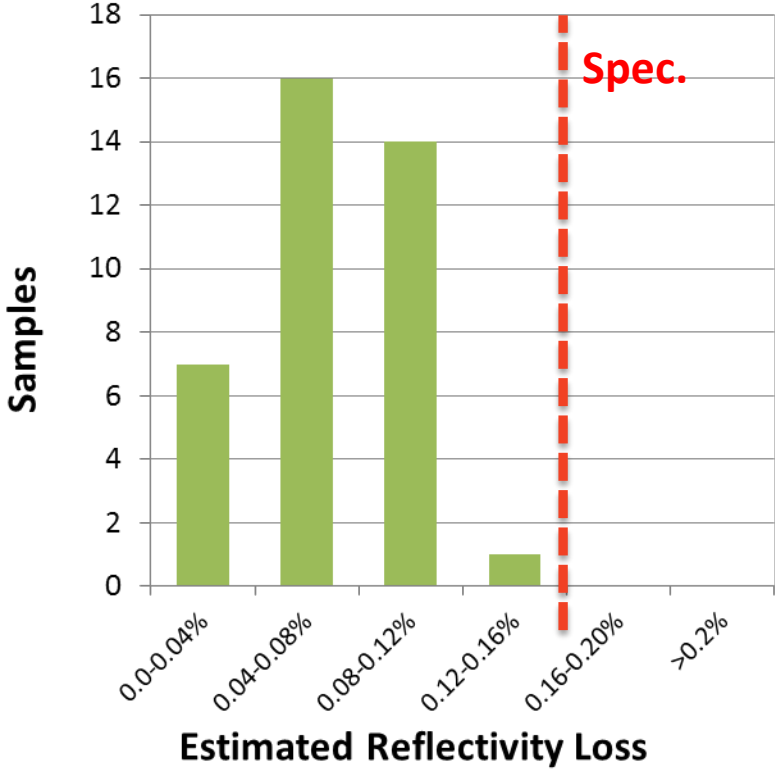
Histogram Results of Cleanable & Non-cleanable

Cleanable Contamination



80% pass the NXE qualification line

Non-Cleanable Contamination



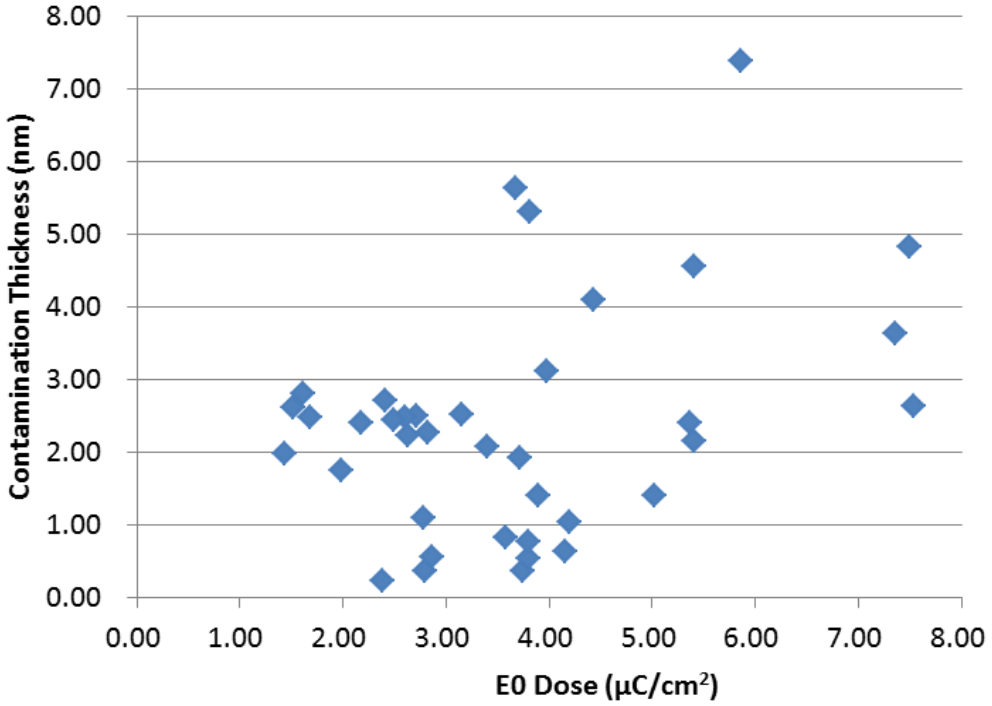
100% pass the NXE3300 qualification line

Cleanable contamination seems more serious than non-cleanable contamination at EIDEC. (similar trend as other test sites)

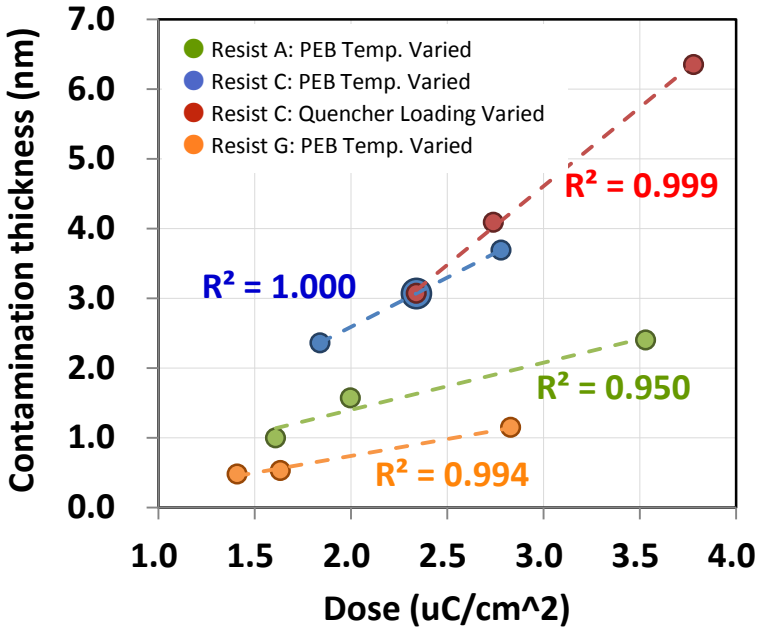
Specifications: N. Harned, ASML, Presentation at IEUVI Resist TWG in Miami (2011)

Contamination Thickness vs. Exposure Dose at E-gun

Tested samples



Resist Composition Considered



No clear linear correlation between contamination thickness and exposure dose.

However, **considering resist composition**, a fine dependency on exposure dose was observed for each resist group. Dose is an effective factor.

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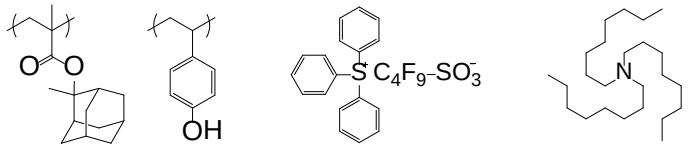
Toward Reduction of Outgas Test Samples

Samples in this study

Investigated Model Resist



Resin PAG Quencher

		PAG loading amount (per hundred resin: phr)		
		10	20	30
Protecting unit ratio (mol%)	50	Resist A	Resist B	Resist C
	40	Resist D	Resist E	Resist F
	30	Resist G	Resist H	Resist I

4 Parameters

[Resist Composition]

(1) Protecting Unit Ratio of Resin

Range: 30 ~ 50 %

(2) PAG Loading

Range: 10 ~ 30 phr

(3) Quencher Loading

Range: 0.1 ~ 0.2 mol. of PAG

[Process Condition]

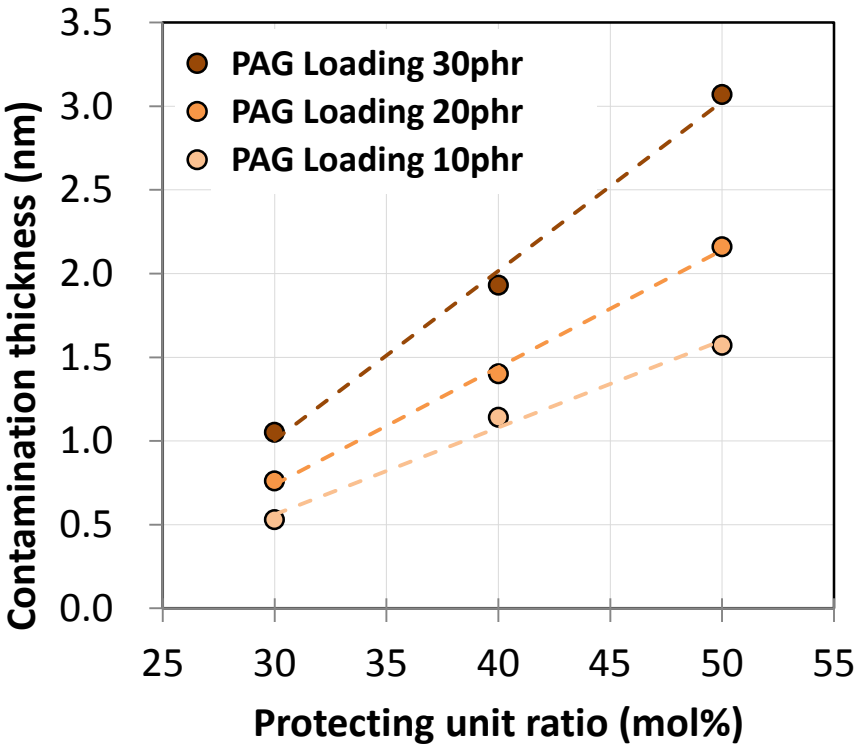
(4) PEB Temperature

Range: 90 ~ 110 deg. C

Tested using EUVOM-9000 (e-gun based)

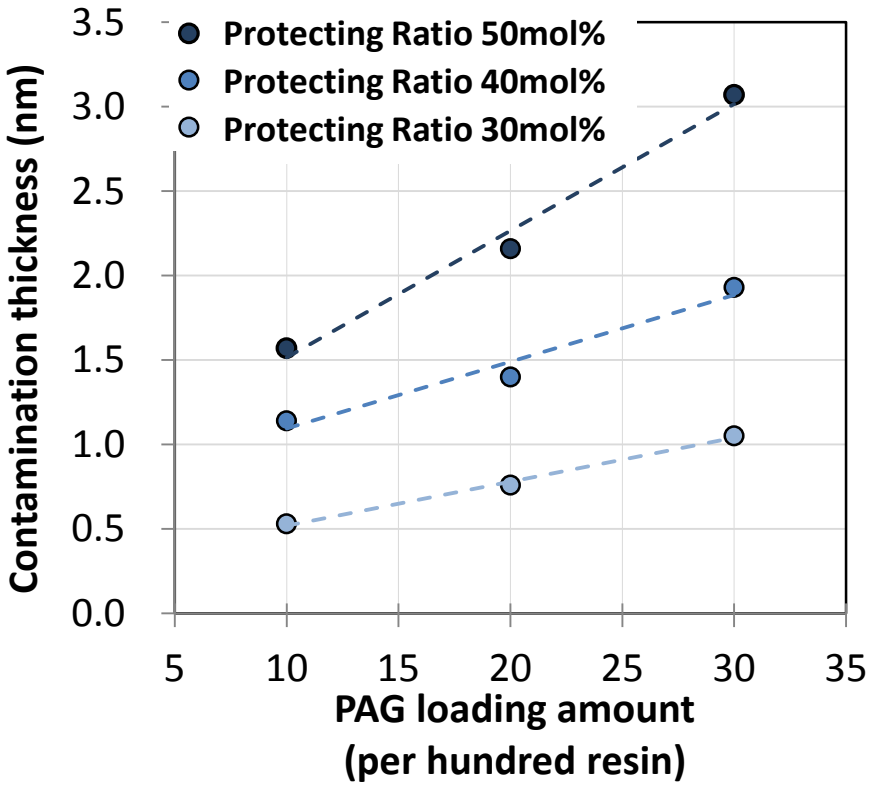
Contamination Dependency (1) on Parameters

(1) Protecting Unit Ratio



No inflection point

(2) PAG Loading

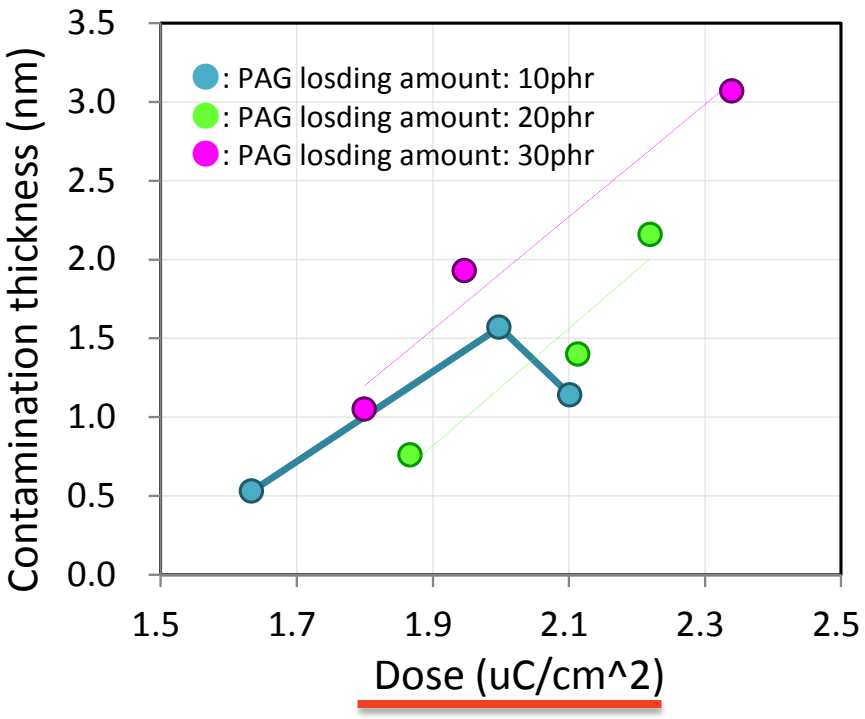


No inflection point

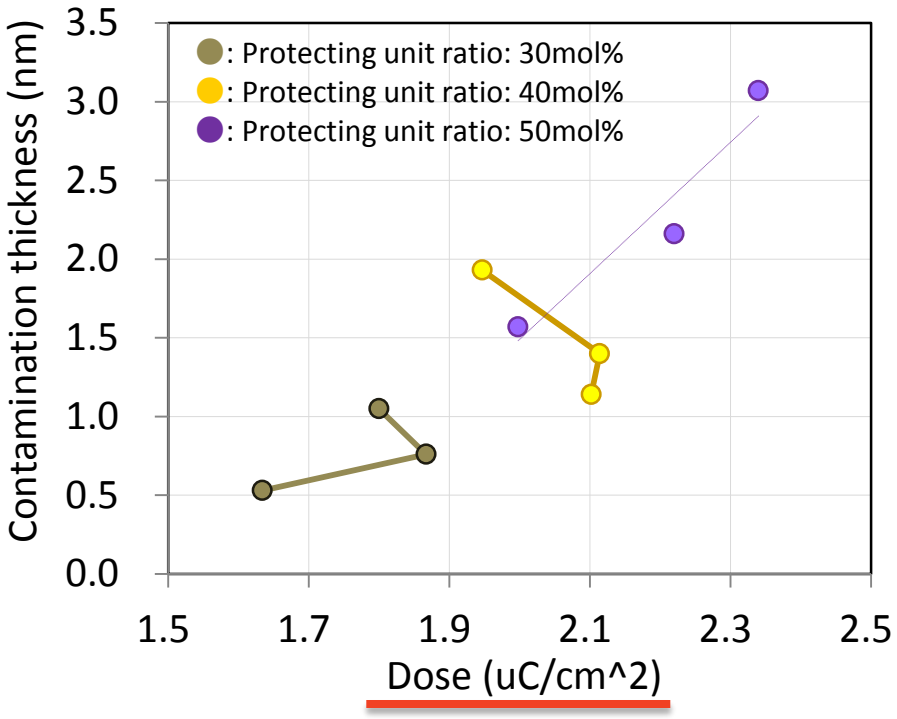
Quencher loading: 0.1 mol for PAG
PEB Temperature: 100 deg. C

Contamination Dependency (1) on Exposure Dose

(1) Protecting Unit Ratio



(2) PAG Loading

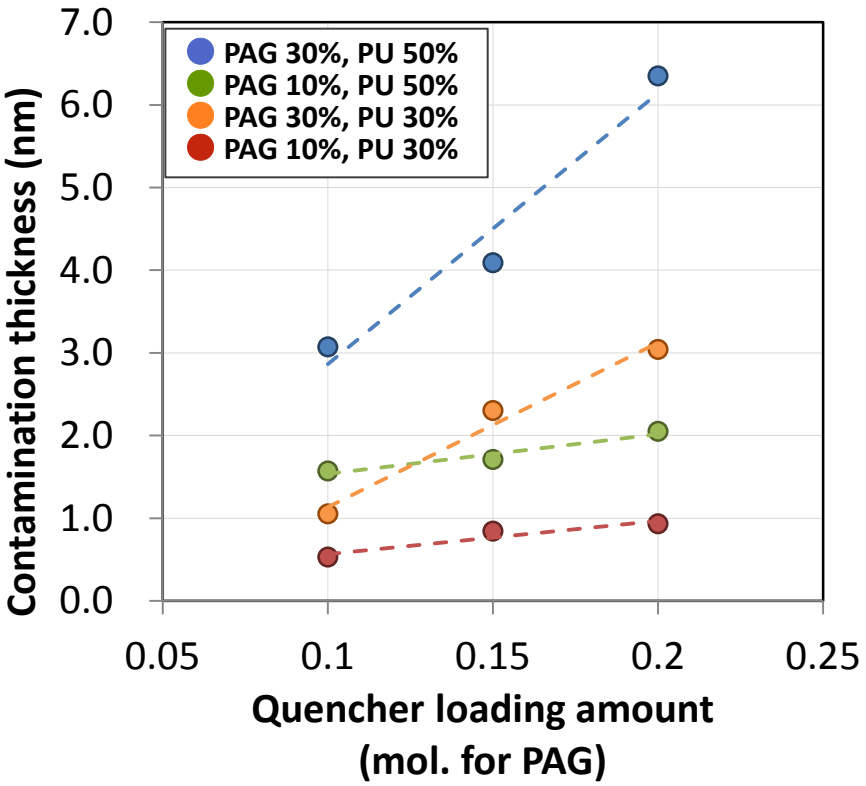


[In case of Protecting unit ratio and PAG loading]

No clear correlation between Contamination thickness and **Dose**

Contamination Dependency (2) on Parameters

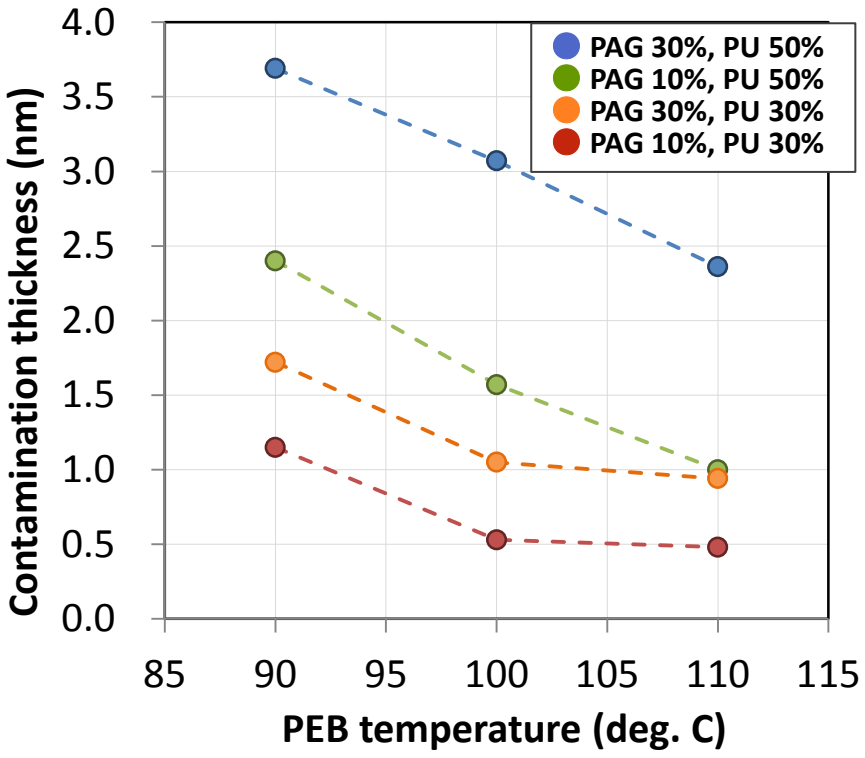
(3) Quencher Loading



Sample		PAG loading amount (per hundred resin: phr)		
		10	20	30
Protecting unit ratio (mol%)	50	A	B	C
	40	D	E	F
	30	G	H	I

No inflection point

(4) PEB Temperature

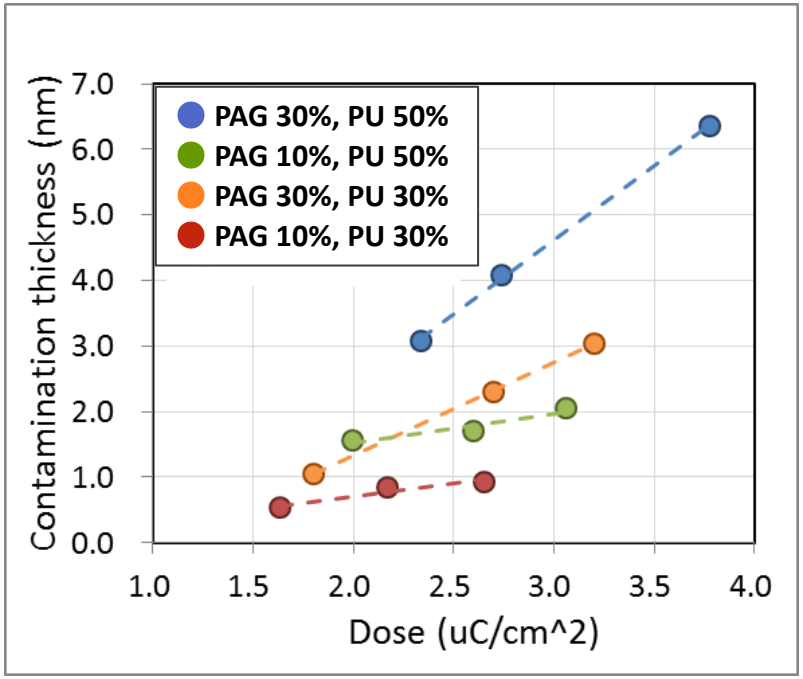


No inflection point

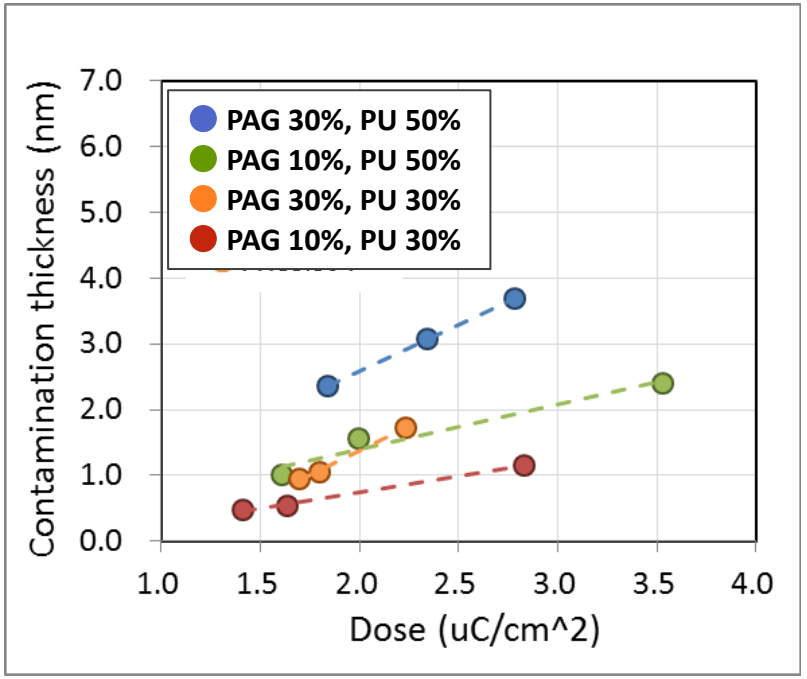
PEB Temperature: 100 deg. C (for Quencher Loading Study)
Quencher loading : 0.1 mol for PAG (for PEB Temperature Study)

Contamination Dependency (2) on Exposure Dose

(3) Quencher Loading



(4) PEB Temperature



[In case of Quencher loading and PEB temperature]

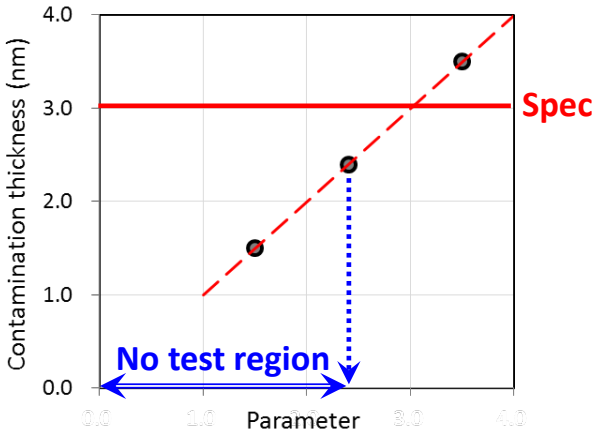
Clear correlation between Contamination thickness and **Dose**!!

So, can we reduce samples for outgas testing?

Suggestion to reduce number of resist outgas tests

Outgas test samples can be reduced through the careful understanding of outgassing tendencies.

(1) If you vary **protecting unit ratio** and/or **PAG loading** …



- Define trend at minimum of 3 points
- Determine threshold using with-in spec result
- **Exclude** samples in “no-test-required” range

(2) If you vary **quencher loading** and/or **PEB temperature** …
(at fixed protecting unit ratio/PAG loading for a specific resist)

- Evaluate sensitivity of samples at new parameters
- **Exclude** from testing if sensitivity is constant/become faster

[Poster Presentation in SPIE 2013; No.8679-85]
Norihiko Sugie et al., 18:00-20:00 Feb. 27th (Wed) Visit!

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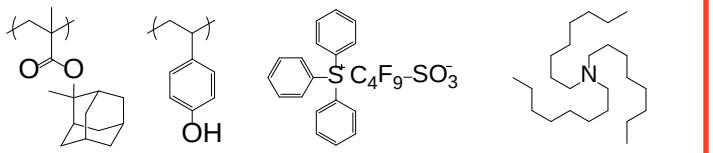
PAG Anion-Contaminant Dependency on WS Geometry

Before H-Cleaning case (as depo.)

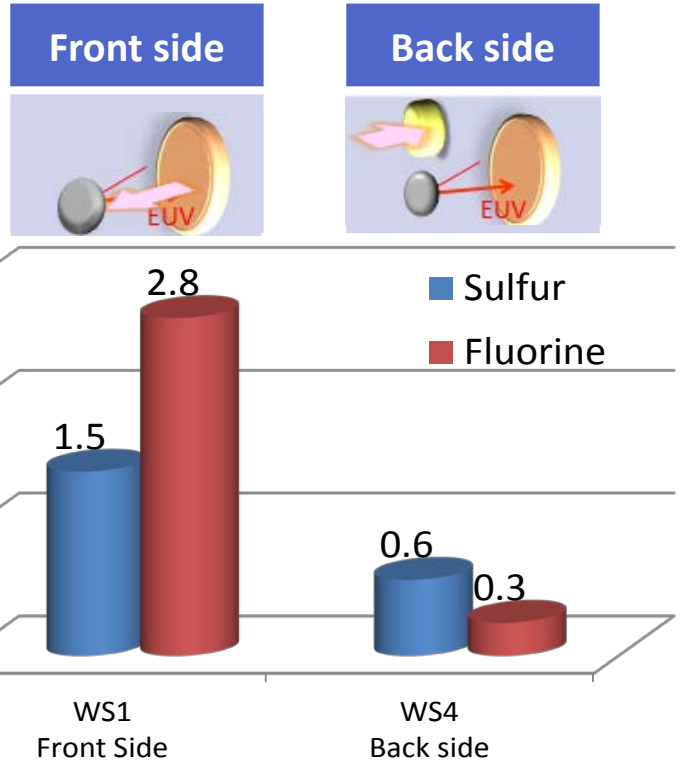
Investigated Model Resist



Polymer PAG Quencher

PAG anion contaminants cannot reach the WS placed facing opposite (backside) the contamination source.
This was because the sticking coefficient of PAG anion is considered high.

WS geometry



[Oral Presentation in SPIE 2013; No.8679-21]
Yukiko Kikuchi, et al., 14:20-14:40 Feb. 26th (Tue)
(Eishi Shiobara)

Visit!

High power EUV research is collaboration with Univ. of Hyogo.

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Summary

- **113 samples** in sum total were tested by Feb. 22th 2013.
  60 samples from the total are customer samples.

- Considering protecting unit ratio and PAG loading;
  clear correlation with contamination thickness was obtained for both parameters. However, this correlation was not the same for dose.

- Considering quencher loading and PEB temperature;
  clear correlation with contamination thickness was obtained for both parameters. For these parameters, a clear correlation with dose was also observed.

- **Guidelines on resist outgas test sample reduction** were suggested.
  (based on evaluated data)

- Fundamental research results on the effect of **WS geometry** on PAG anion contamination was presented.

Acknowledgement

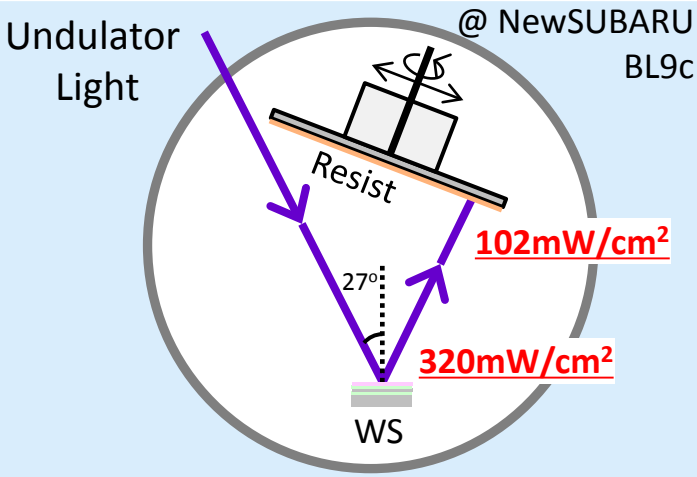
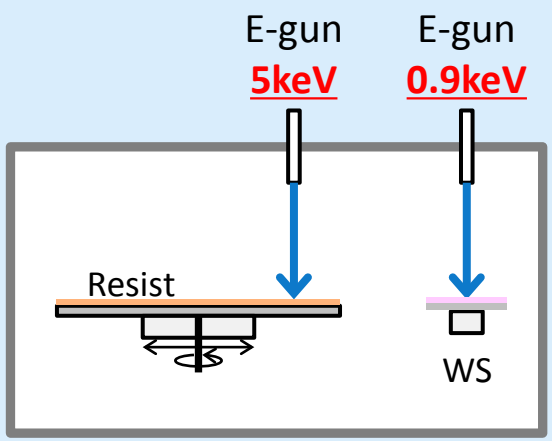
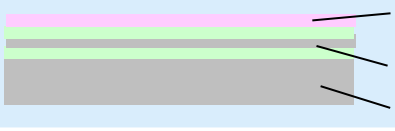
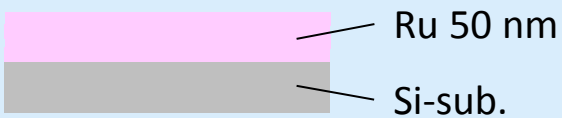
This work is supported by New Energy and Industrial Technology Development Organization (**NEDO**).

We would like to thank EIDEC member companies of resist outgassing control program.

FUJIFILM, JSR, SanDisk, Shin-Etsu Chemical, TOK, and TOSHIBA

Thank you.

[Appendix]

	High Power EUV - HERC* analysis tool -	E-gun - EUVOM-9000 -
Tool Geometry		
Vacuum Conditions	Base Pressure : 2~4 x 10^{-6} Pa Exposure Pressure : 1~2 x 10^{-5} Pa	
Resist Thickness	60 nm	
Dose for Contamination Growth	2.5 x Eo	~ 2.5 x Eo
	Eo is measured at each tool, respectively.	
Witness Sample (WS)		

* HERC = **H**igh power **E**UV **R**esist **C**ontamination