



# *Optimization of EUV resists under the limitation of outgas specification*

**Kenji Hoshiko, Yusuke Anno, Xavier Buch**

**JSR Micro N.V.**

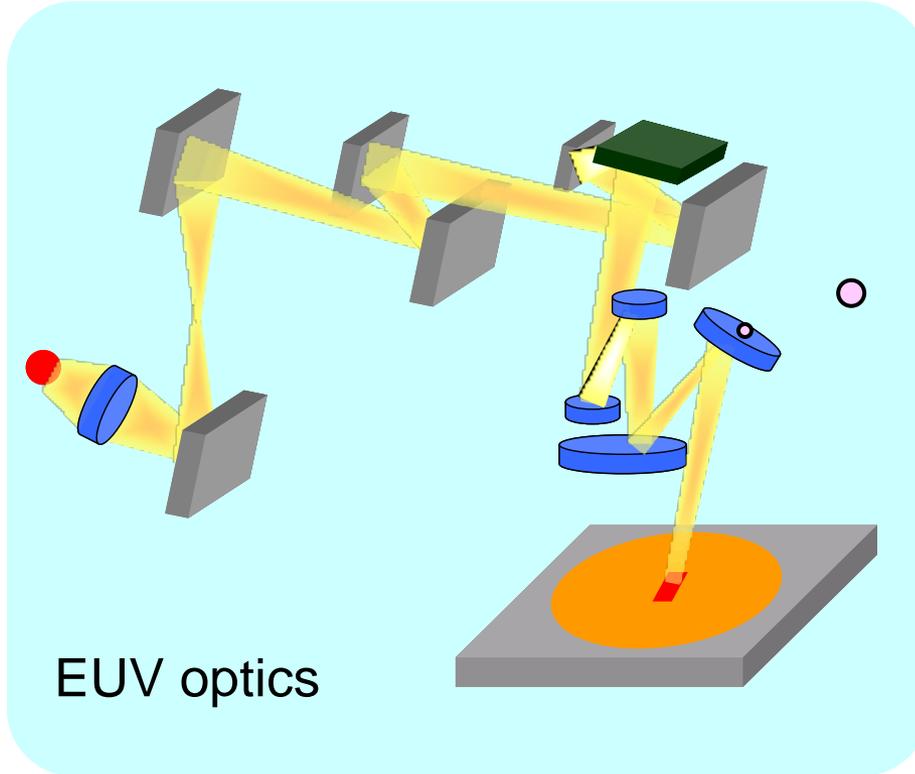
**Makoto Shimizu,**

**JSR Corp.**

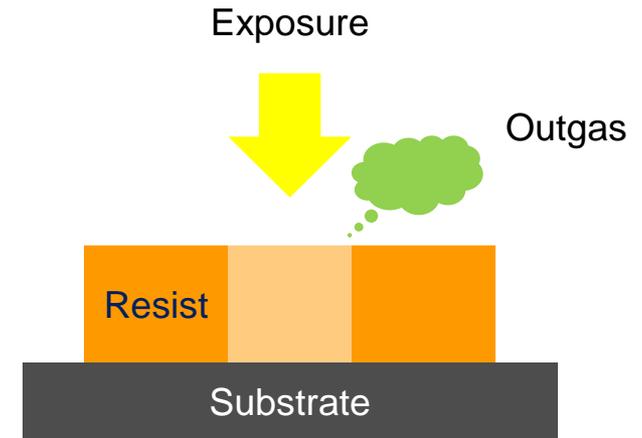
# Outline

- **EUV outgassing**
- **The current issue on resist development**
- **Alternative easy method to estimated outgassing**
- **Results and outcome**
- **Conclusion and Future Work**

# Introduction



EUV power gets lost by contamination of mirror

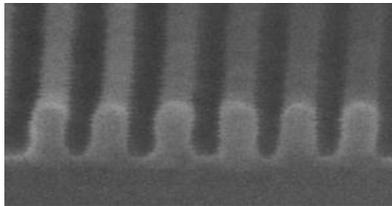
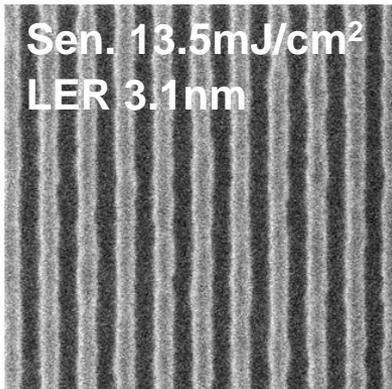


- ✓ Contamination of the optics by the resist outgassing is one of important technical issues on EUVL.
- ✓ Establishment of preliminary outgas measurement method is required to accelerate resist development.

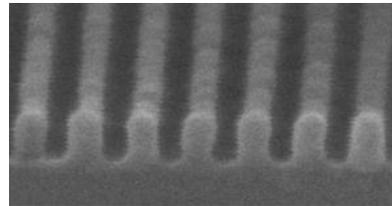
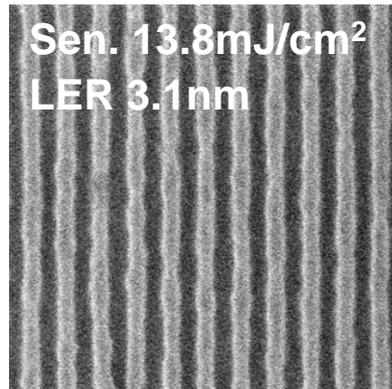
# The Current Issues of Resist Development

## LS Performance

### 22nm LS

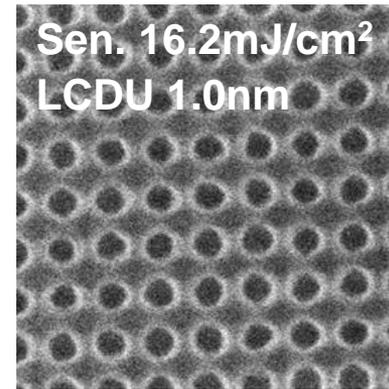


### 20nm LS

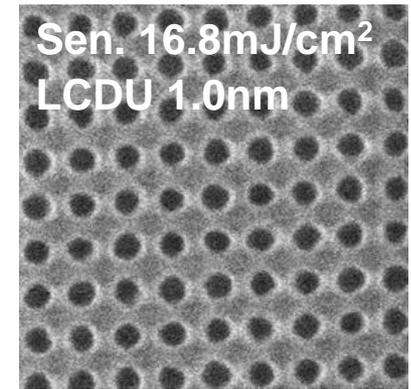


## CH Performance

### 28nm CH



### 26nm CH



LS : NXE3100@imec, NA0.25, Dipole60X  
with FIRM™ rinse.

LER: 3σ

CH : NXE3100@imec, NA0.25, Quasar45

LCDU: 1σ

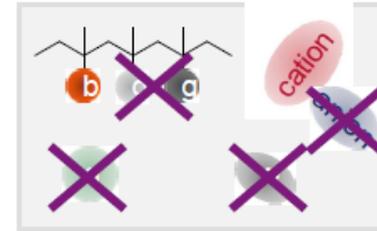


- ✓ One of the limitations is outgas measurement capacity.
- ✓ This is not enough for new samples compared to the opportunity to be exposed on full field exposure tools.

# Outgas Measurement Method

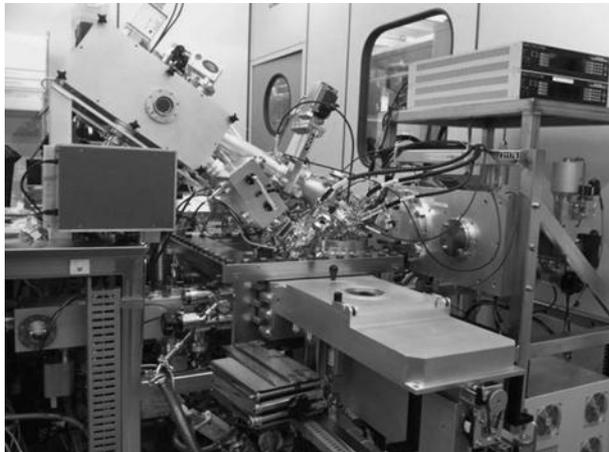
Ivan Pollentier et al, SPIE2011

- ✓ Resist outgas is measured by thickness growth on witness plate with EUV or EB exposure.
- ✓ Outgas source is known as decomposed elements from a resist such as protective group on polymer and photo acid generator.

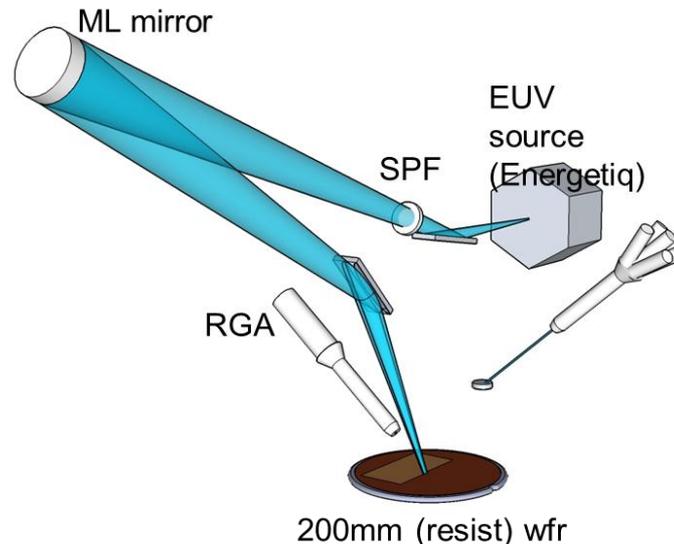


Non blocking groups, quencher PAG anion, and solvent is not seen in the outgassing and should therefore not contribute to the contamination;

PAG cation and blocking groups are present in outgassing, and are therefore important;



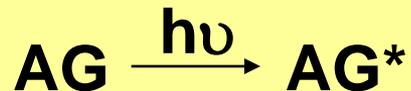
Imec outgas tester configuration



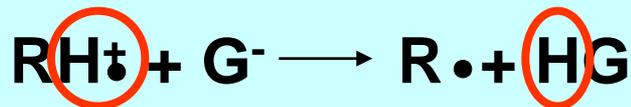
# Resist Reaction Mechanism by EUV/ EB exposure

Ionization potentials		Exposure energy	
Hydrogen	13.6 eV	KrF(248nm)	5.0 eV
Carbon	11.3 eV	ArF(193nm)	6.5 eV
Oxygen	13.6 eV	EUV (13.4nm)	<b>92 eV</b>
		EB	>2000 eV

## Direct excitation (KrF, ArF, EUV:5%)



## Ionization (EB, EUV:93%)



AG: Acid generator

RH: Base resin

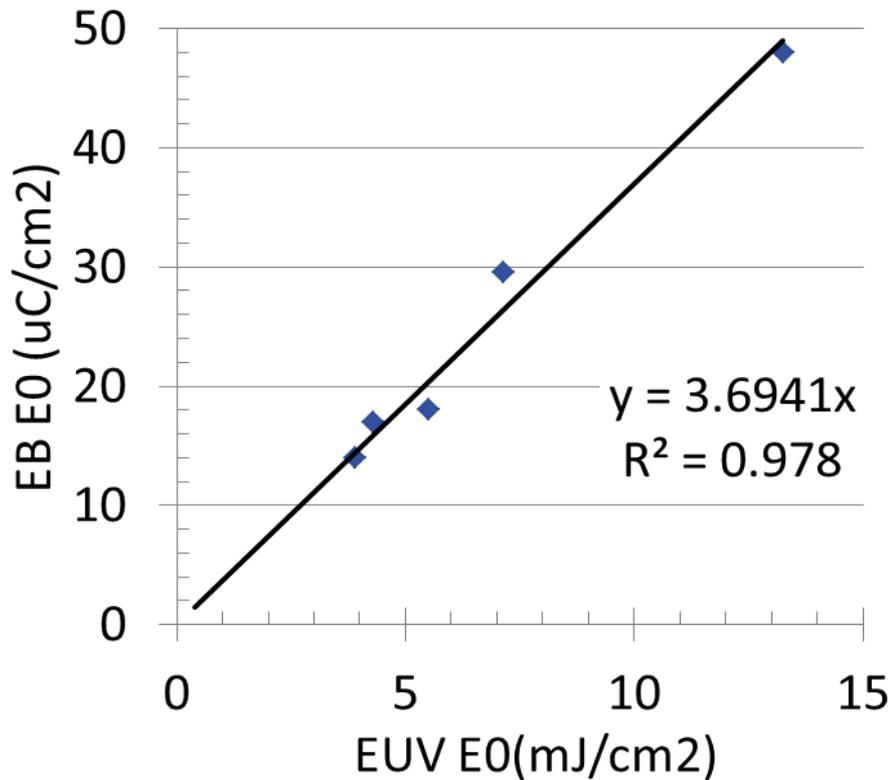
RH<sup>+</sup>: Radical cation of base resin

A: Decomposed fragment of AG

G<sup>-</sup>: Counter anion of AG

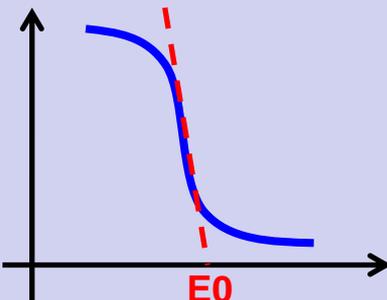
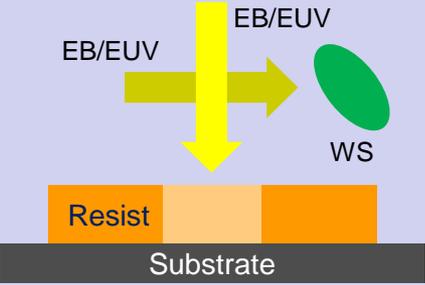
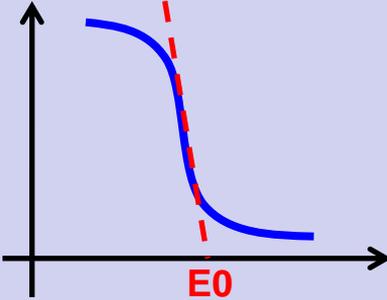
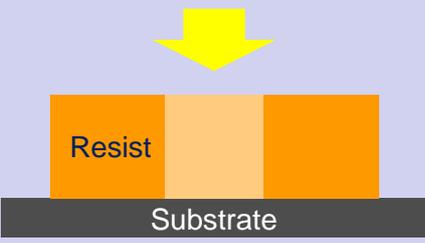
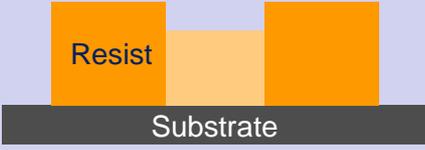
In EUV and EB exposure, resist reaction through "ionization process" is major path different from light excited reaction.

# Correlation between EB and EUV



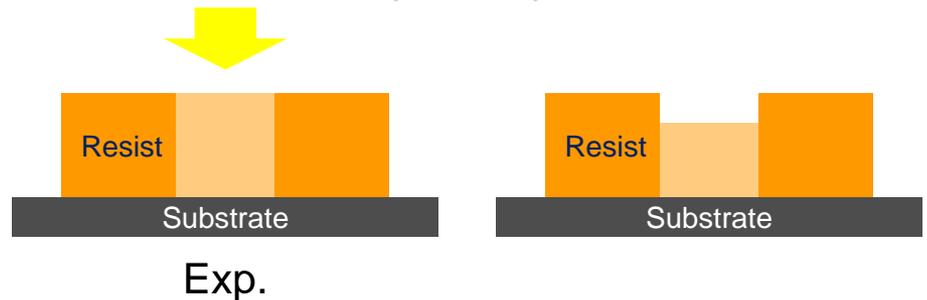
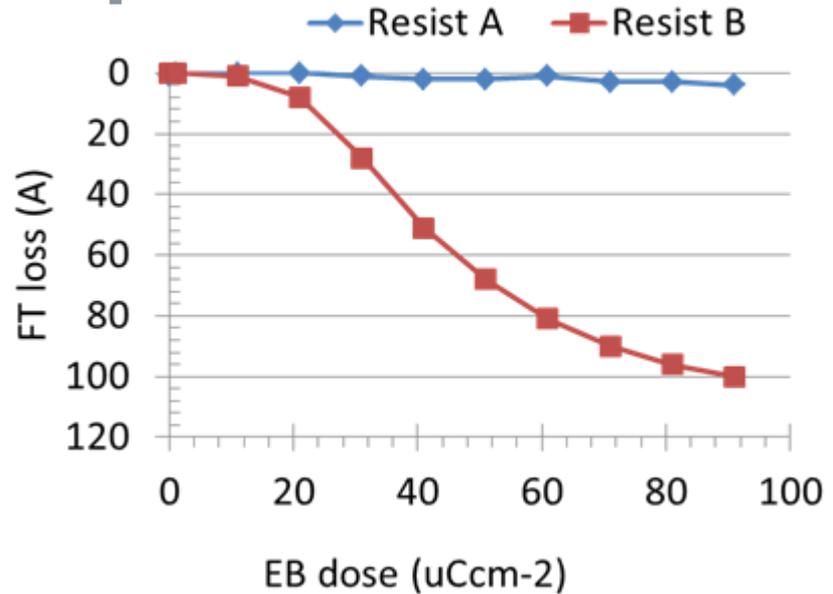
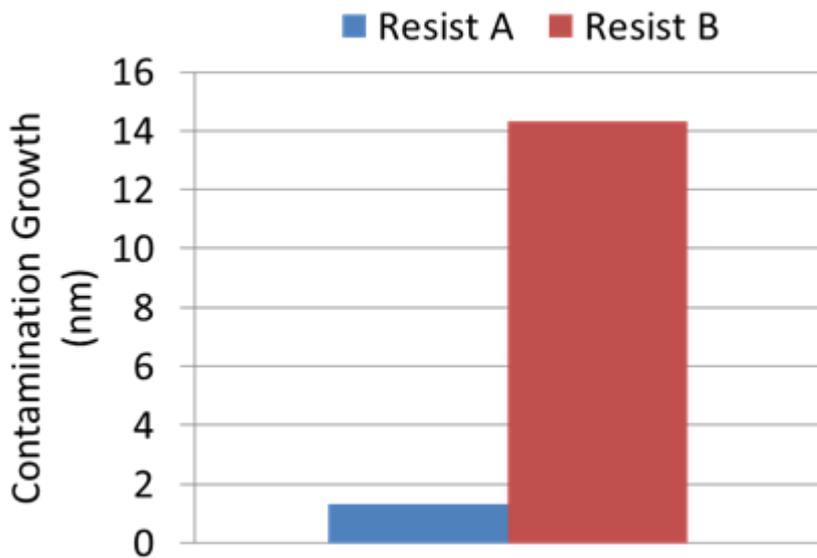
- ✓ E0 values of EUV and EB exposure showed good correlation from each other.

# Preliminary Outgas Measurement Method

	Step 1	Step 2	Step 3
Standard	<p>E0 testing</p>  <p>By EB/EUV on OG tool</p>	<p>Grow contamination</p>  <p>On OG tool</p>	<p>Measure contamination growth</p>  <p>By ellipsometer</p>
Alternative	<p>E0 testing</p>  <p>By any EB tool</p>	<p>Volatilize contaminating species by EB exp</p>  <p>On track</p>	<p>Measure FT loss</p>  <p>By ellipsometer</p>

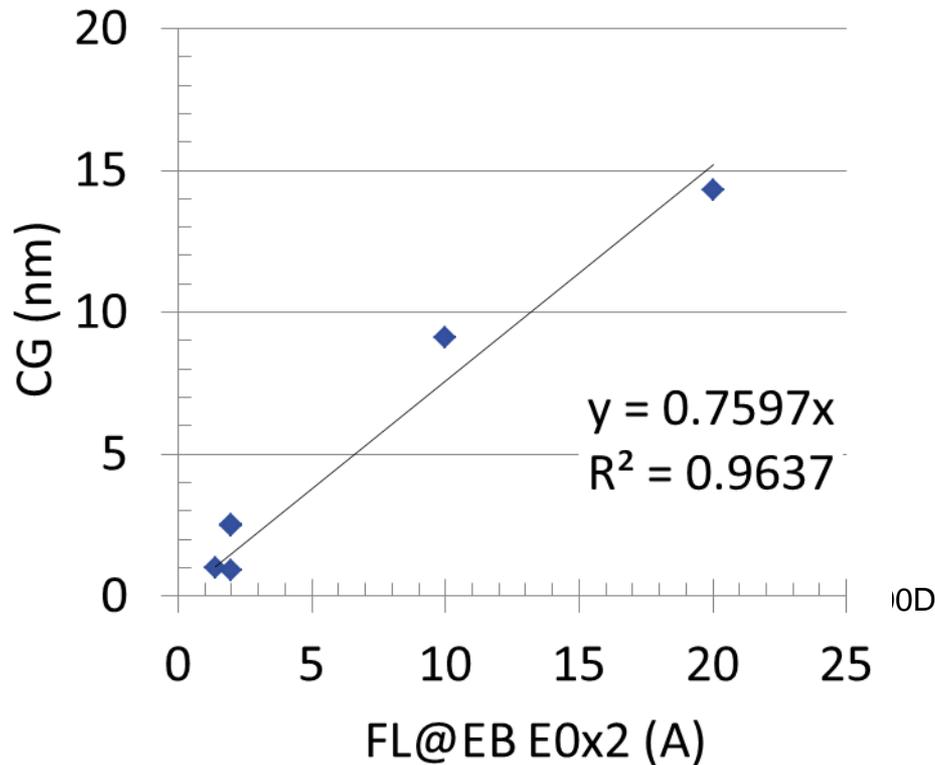
**Resist film analysis instead of outgas detection was tested.**

# Resist Thickness Change by EB exposure



- ✓ Thickness change by EB exposure represented outgas amount measured by standard measurement method.

# Correlation between Resist thickness Loss and Contamination Growth



- ✓ Resist thickness loss and contamination growth showed good correlation.
- ✓ This means that pre-measurement of resist thickness loss is in principle able to exclude the resists giving high outgassing amount.

# Conclusion and Future Work

- **AS alternative outgas measurement method, FT loss with EB E0 was studied in this presentation.**
- **The authors confirmed a good correlation in EUV outgas and EB FT loss**
- **By using this useful method, the authors are expecting more progress on resist development.**
- **As a future work, non-cleanable outgas will be investigated.**

# Acknowledgement

***The authors gratefully thank imec for the close collaboration and opportunities for evaluation.***

*Materials Innovation*



**With chemistry, we can.**