



# UPDATE ON EUV OUTGASSING IMEC

I. POLLENTIER



# Status of resist outgassing qualification for NXE3100

## Investigation of outgassing and contamination in multilayer schemes



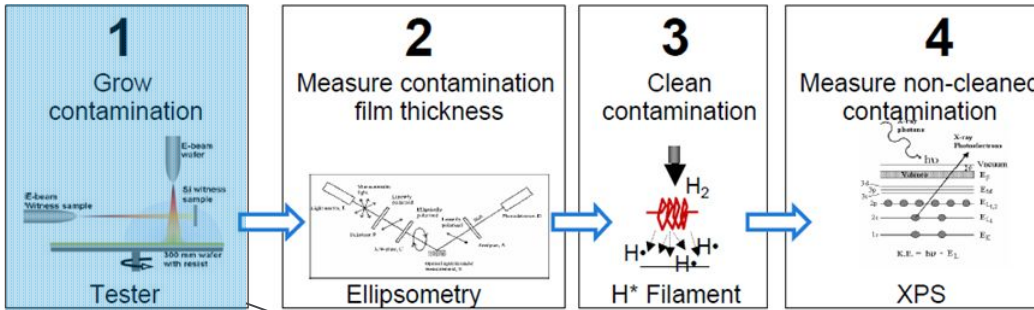
# STATUS ON RESIST OUTGAS QUALIFICATION FOR NXE3100

I. POLLENTIER, AND R. LOKASANI

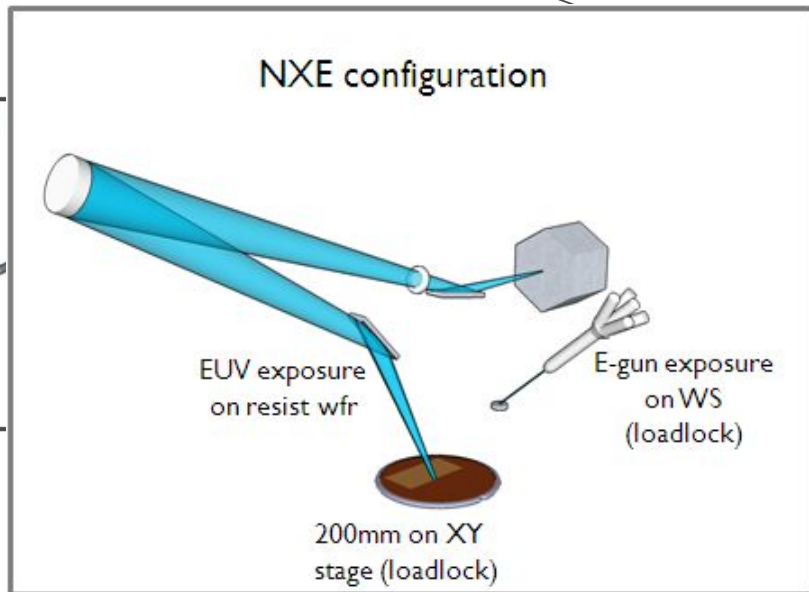


# OUTGASSING QUALIFICATION FOR NXE3100 STATUS MARCH'11

[N. Harned (ASML), IEUVI Resist TWG meeting, Nov'2010]

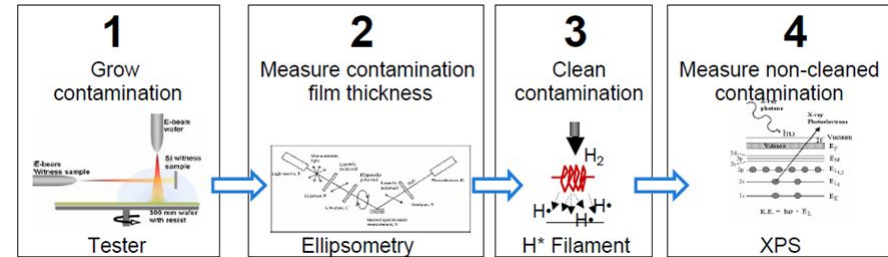


Data package	Data description
1 Facilities	a Specification resist processing (uniformity and repro)
	b Specification ellipsometer
	c Ellipsometry C or SiO2 on Si sample (fixed thickness cross ref)
	d Ellipsometry Si/Ru/C peak sample
	e Specification XPS
	f XPS 3-layer sample (SiN/TiN/SiN)
	g XPS Si / Ru / cleaned contamination ASML reference sample
2 Vacuum	a RGA spectrum of ultra clean vacuum with pressure reading
	b Pumping speed data of calibration mixture
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	d Exposed area and test timing contamination growth test
	e Reproducibility of contamination growth exposure
	f Contamination grown from background (total thickness)
	g Contamination grown from background (content)
5 Calibration	a Check outgassing limited contamination growth (bleeding tests)
	b Calibration exposures (4 resists preferred)



Essential hardware modifications  
done on imec outgassing tool  
(vacuum improvement + e-gun)  
ASML first guidelines available  
System used for ADT qualifications  
Work on datapackages started only  
in early May

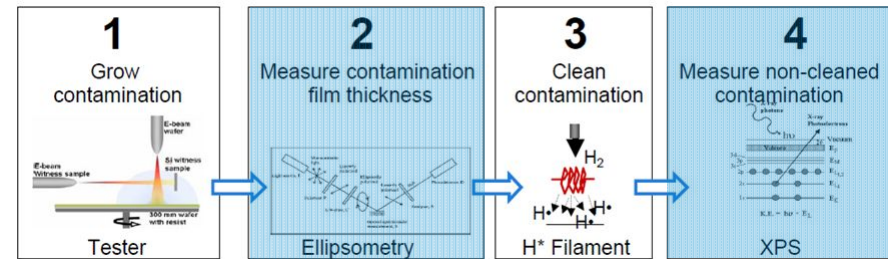
# OUTGASSING QUALIFICATION FOR NXE3100



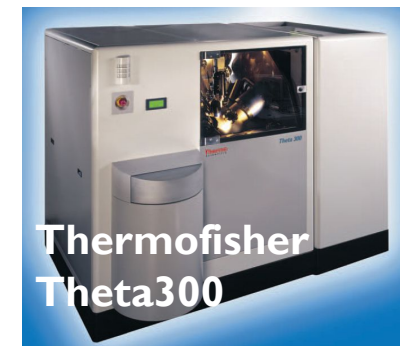
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Where are we ?

# OUTGASSING QUALIFICATION FOR NXE3100

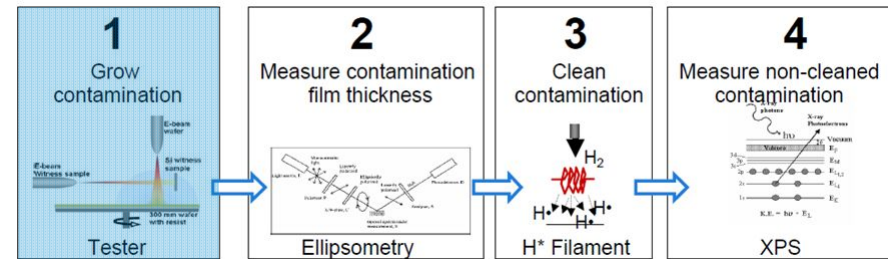


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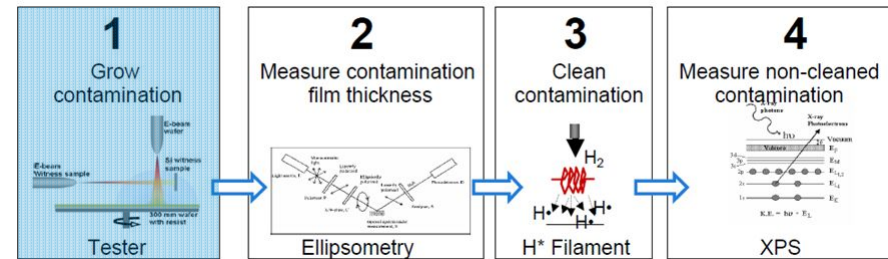
1" WS are measured by 200mm tools by pocket wafers

# OUTGASSING QUALIFICATION FOR NXE3100



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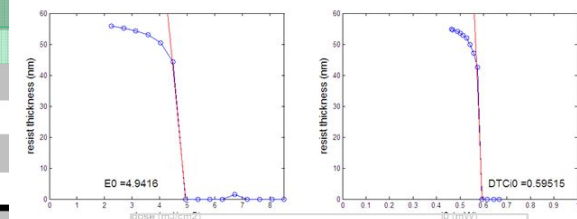
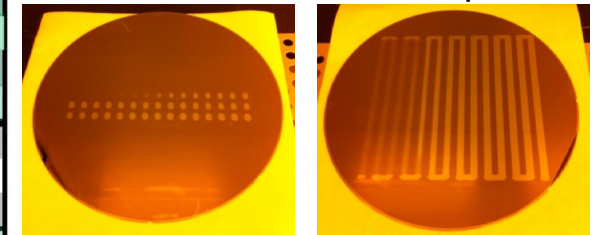


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Dose-to-clear done in 2 ways :

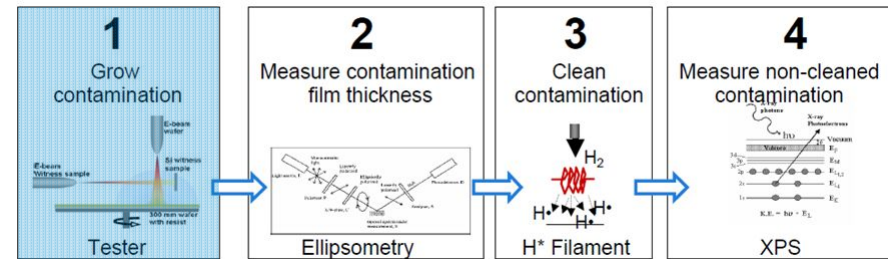
Incr. time @ const int.

Incr. int. @ const speed



$$i0 = 0.11 \cdot E0$$

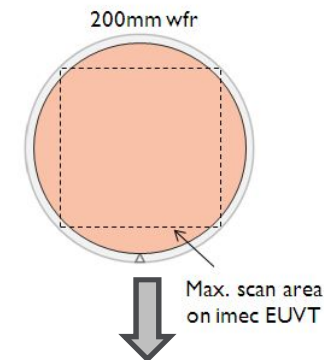
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ASML spec on wafer exposure area :  
 >90% of 200mm wfr (>270cm<sup>2</sup>)  
 during 1hr

## Exposure at E0

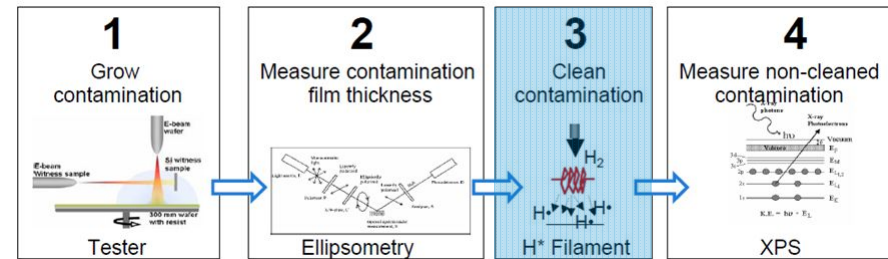


2 wafers will be exposed, each with area  
 ~200cm<sup>2</sup> during ½ hr (total ~400cm<sup>2</sup> in 1hr)

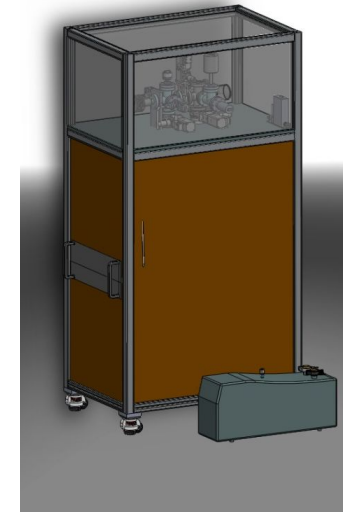
Delay between wafers is estimated to be <45min, but  
 during this time the power intensity can be adjusted.

Remaining CG tests are prepared and ongoing  
 but need verification with WS precleaning

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WS H-cleaner currently developed by EUV Technology will be shipped in December'11

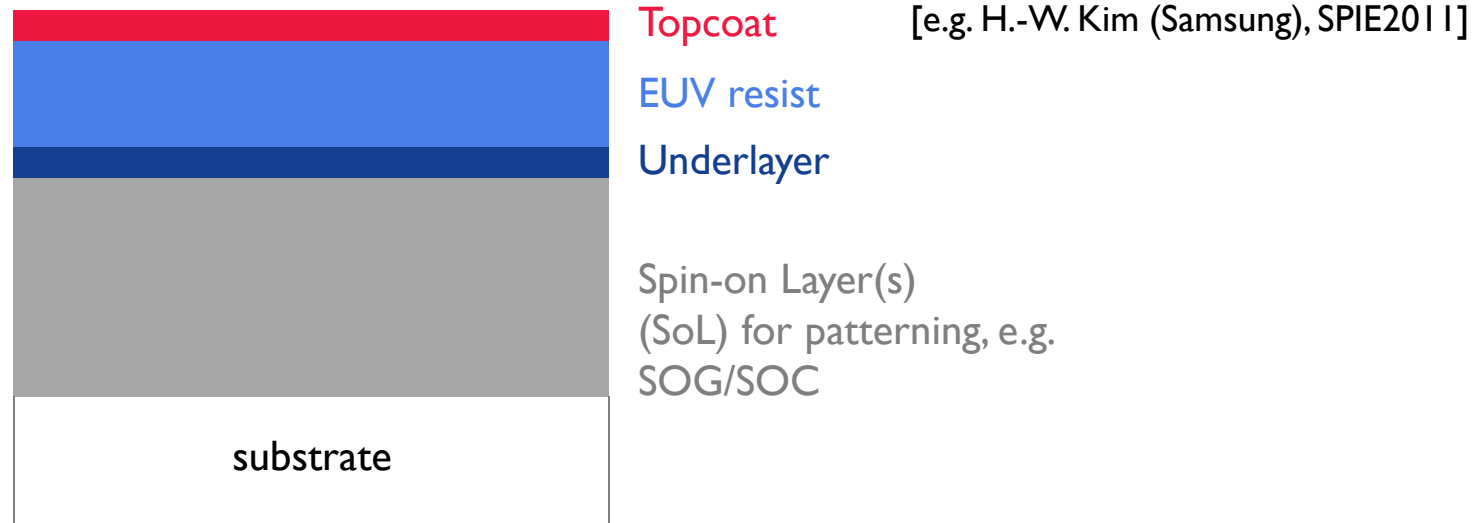


# **EUV OUTGASSING AND CONTAMINATION IN MULTILAYER MATERIAL SCHEMES (EUVL POSTER)**

**I. POLLENTIER, V. TRUFFERT, R. LOKASANI, AND R. GRONHEID**



# EUV MATERIAL STACK



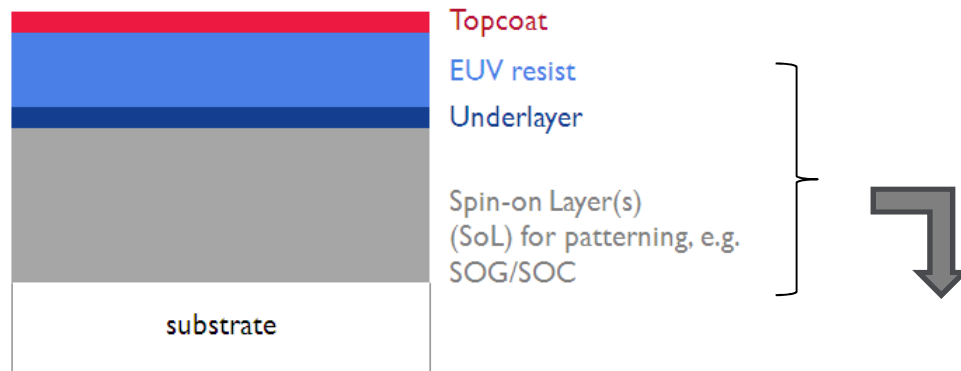
EUV stack can be a complex stack of organic (outgassing) materials.

So far the resist is the main material to be qualified (ASML VWS test), and this without presence of other layers.

In this work some layer combinations are characterized by VWS test.

**However emphasis was put on RGA since this enables additional understanding on mechanisms !**

# IMPACT OF LAYERS BELOW RESIST



*Case 1*

*How much outgassing contamination can be expected from SoL when it is covered with resist?*

*Is resist outgassing changed by underlying material?*

EUV resist  
SoL

*Case 2*

UL  
SoL

*How efficient is an UL for suppression of outgassing & contamination of underlying SoL?*

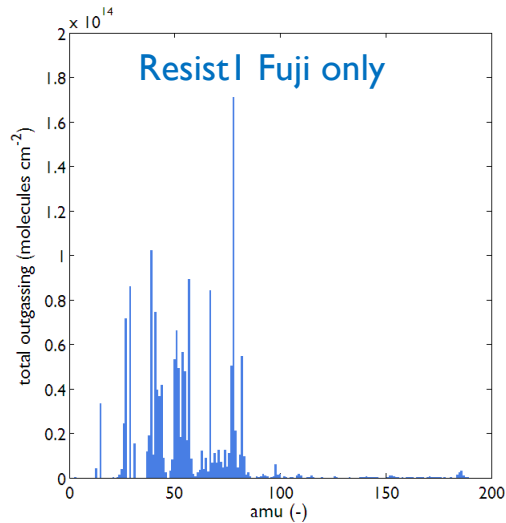
*experimental*

SoL  
1x :  
SOG (Nissan)

UL  
1x :  
Brewer AL412

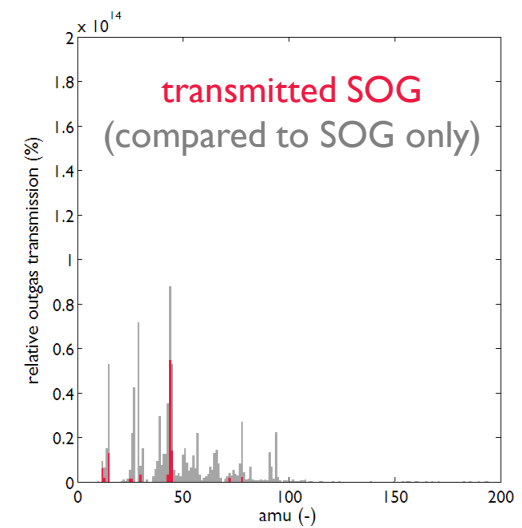
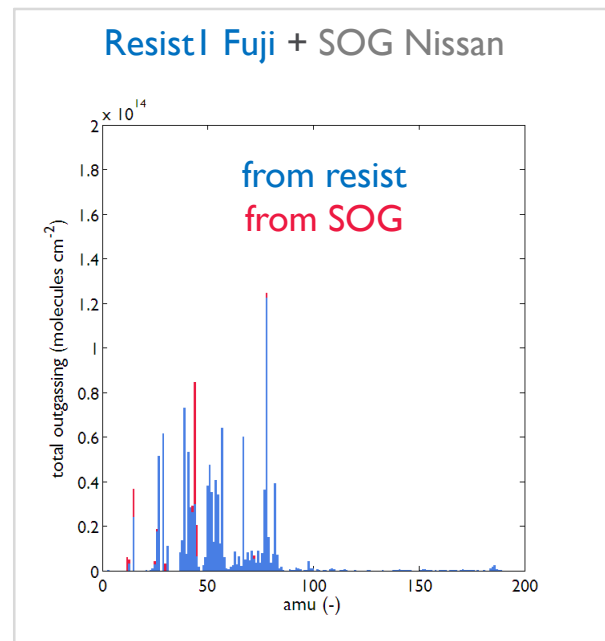
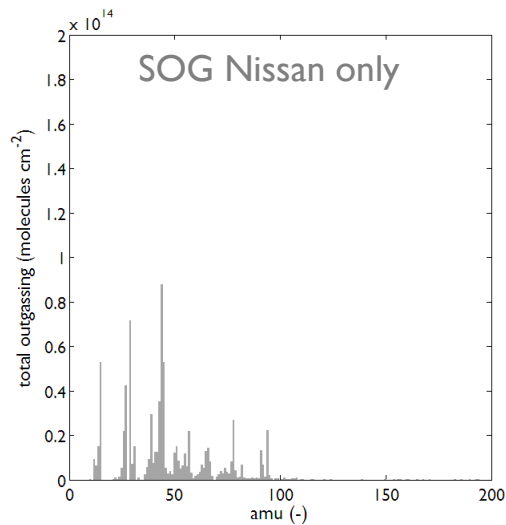
EUV resist  
4x :  
3 model resists FujiFilm  
+ SEVR140

# IMPACT OF LAYERS BELOW RESIST



ResistI (60nm)  
SOG Nissan  
(60nm)

Resist outgassing amount is (slightly) changed  
A small amount of SOG related outgassing is observed



# IMPACT OF LAYERS BELOW RESIST

Resist (60nm)

SOG Nissan  
(60nm)

Resist	T <sub>g</sub> (°C)	MW	Block. Ratio	Resist outgassing change	Transmitted SoL outgassing
FF Resist1	high	high	low	-28%	13%
FF Resist2	low	low	high	-18%	33%
FF Resist3	medium	low	low	-29%	27%
SEVR140	-	-	-	12%	17%
<i>resist chemistry</i>				<i>RGA outgassing</i>	

The transmitted SoL outgassing is related to the resist chemistry, but in line with PAG related outgassing !

# IMPACT OF LAYERS BELOW RESIST

Resist (60nm)

SOG Nissan  
(60nm)

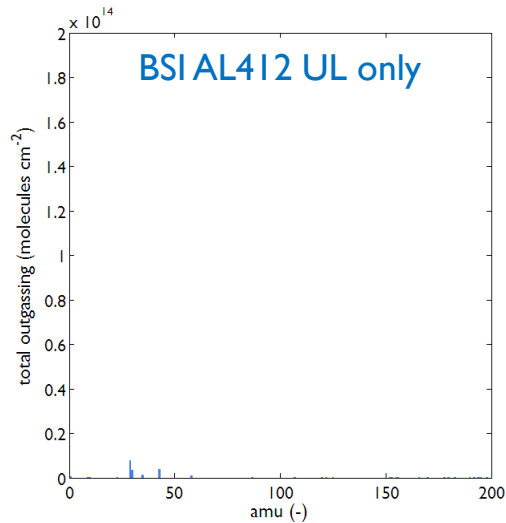
**WS cont.  
thickness\***  
**SOG : 0.05**

\* Using initial e-gun method (1 wafer at higher dose)

Resist	T <sub>g</sub> (°C)	MW	Block. Ratio	Resist outgassing change	SoL transmission	WS cont. thickness <u>resist</u> * (nm)	WS cont. thickness <u>stack</u> *
FF Resist1	high	high	low	-28%	13%	0.40	-
FF Resist2	low	low	high	-18%	33%	1.38	-
FF Resist3	medium	low	low	-29%	27%	0.83	0.84
SEVR140	-	-	-	12%	17%	0.75	0.85
<i>resist chemistry</i>				<i>RGA outgassing</i>		<i>WS contamination</i>	

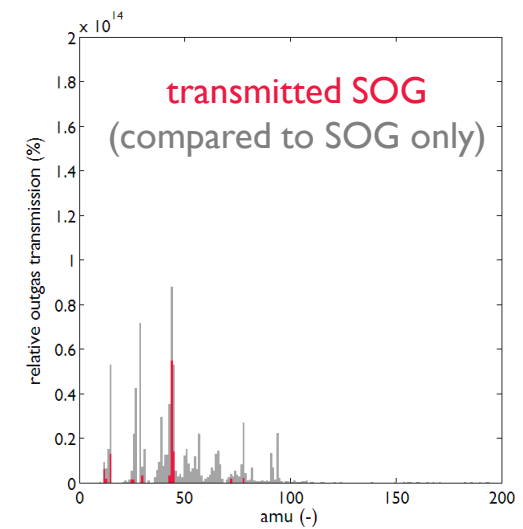
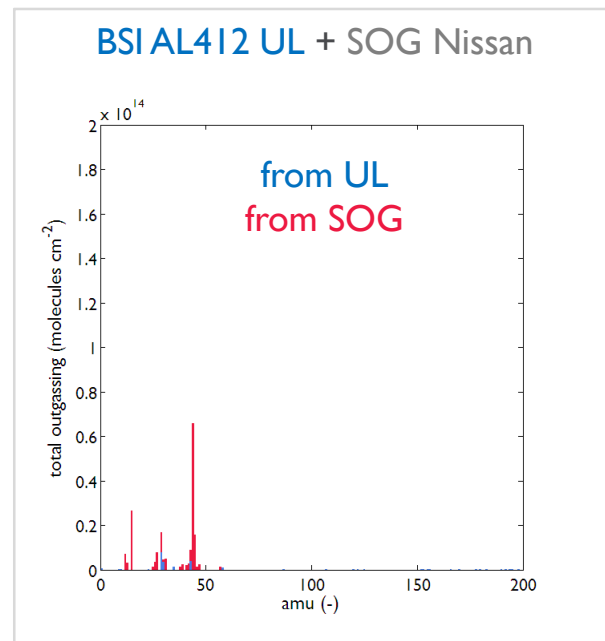
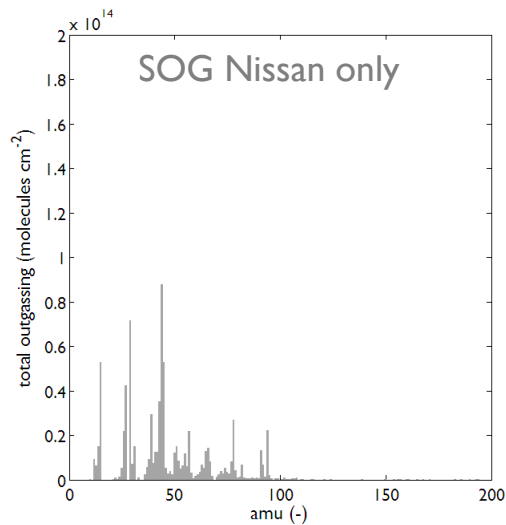
WS contamination can be slightly changed by underlying SoL stack, but it is believed that this is not because of SoL related outgassing but only by change in resist related outgassing

# IMPACT OF LAYERS BELOW RESIST

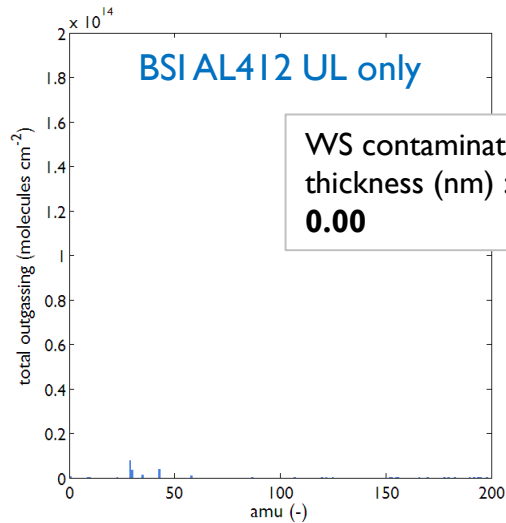


BSI AL412 (12nm)  
SOG Nissan  
(60nm)

Only minor fraction (~20%)  
and low AMU part of SOG  
outgassing is measured in stack



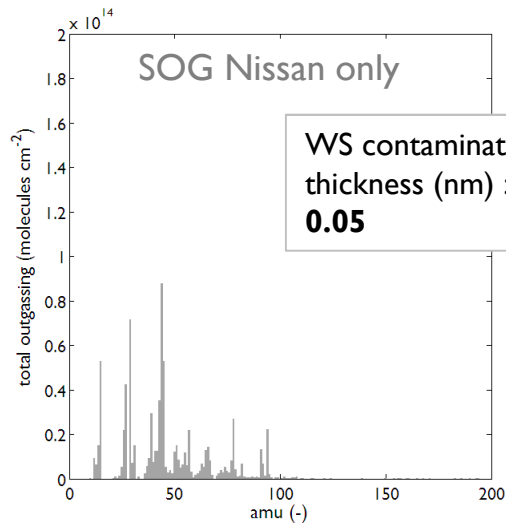
# IMPACT OF LAYERS BELOW RESIST



WS contamination thickness (nm) :  
**0.00**

BSI AL412 (12nm)

SOG Nissan (60nm)

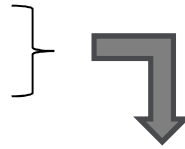
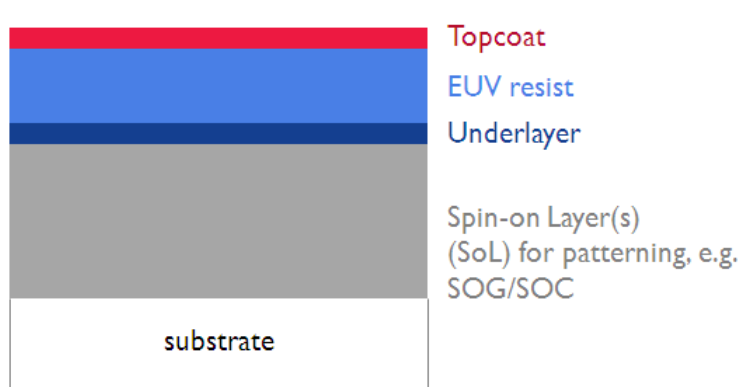


WS contamination thickness (nm) :  
**0.05**

Contamination of UL and SoL is very low, so minor risk is expected from combined stack.

\* Using initial e-gun method (1 wafer at higher dose)

# IMPACT OF LAYERS ABOVE RESIST



*How efficient is a topcoat for suppression of outgassing & contamination of underlying resist ?  
Is a topcoat resulting in contamination ?*



*experimental*

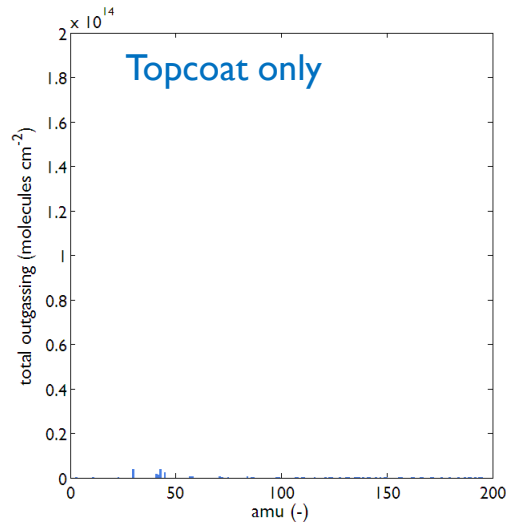
EUV resist

4x :  
3 model resists FujiFilm  
+ SEVR140

Topcoat

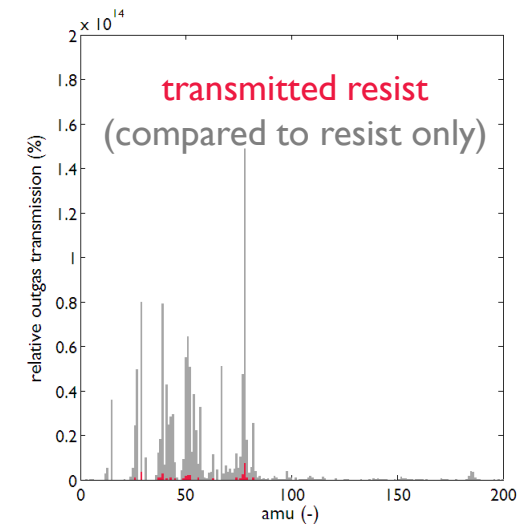
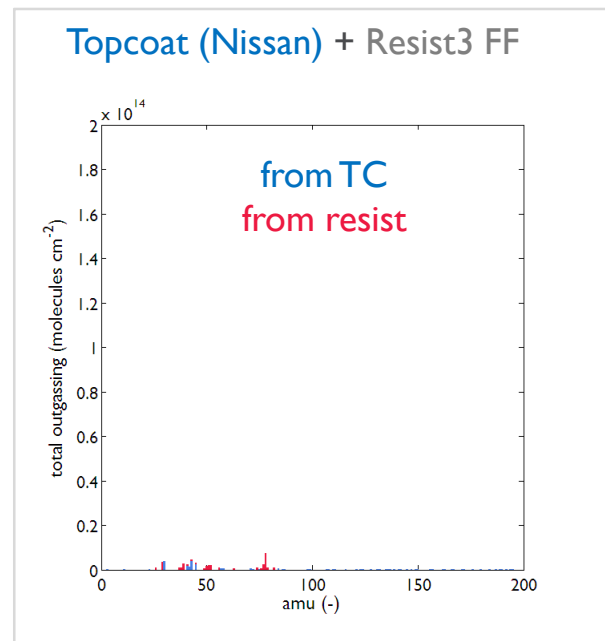
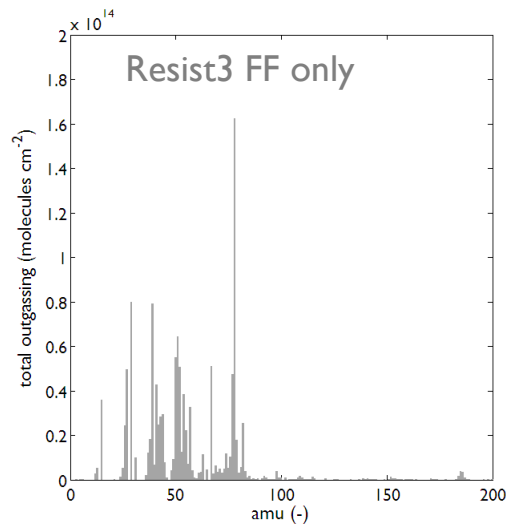
2x :  
Nissan

# IMPACT OF LAYERS ABOVE RESIST

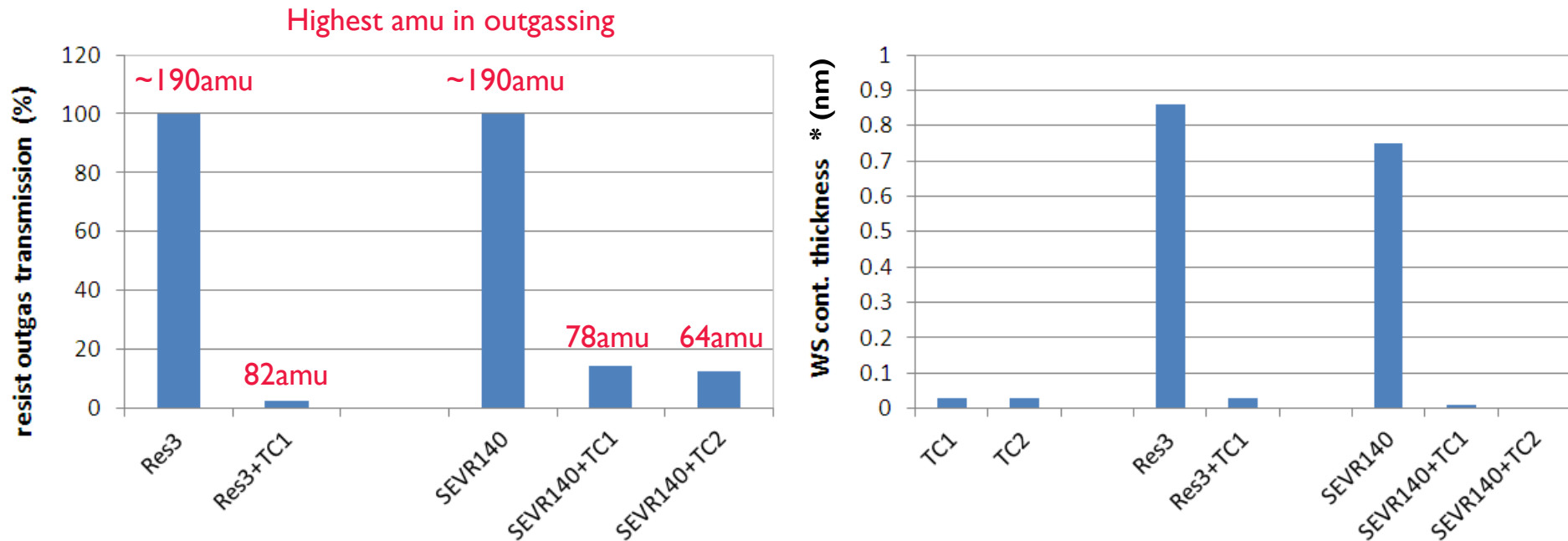


TC Nissan(30nm)  
Resist3 (60nm)

Only very minor fraction and low AMU part of resist outgassing is measured in stack  
*contamination ?*



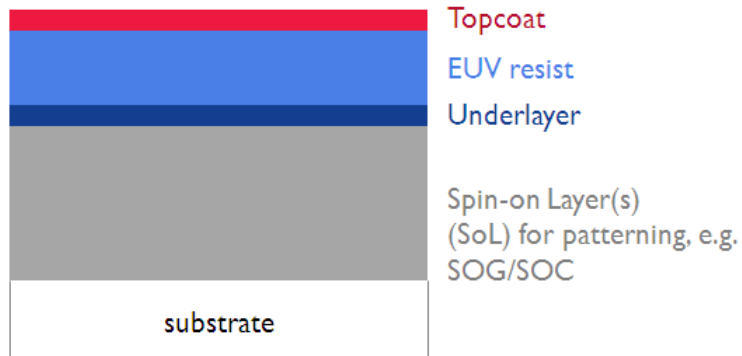
# IMPACT OF LAYERS ABOVE RESIST TOPCOAT



Investigated TC's are very effective in reducing both outgassing and contamination !!!

\* Using initial e-gun method (1 wafer at higher dose)

# SUMMARY

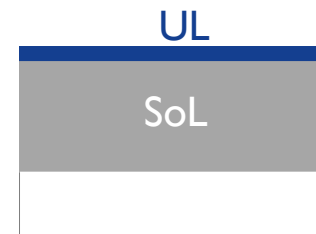
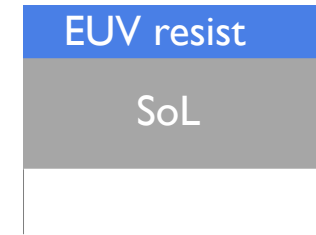


***This investigation confirms that resist is the main contributor to outgassing and contamination.***

***However the resist related outgassing and contamination can be slightly changed by the presence of an underlying layer.***

***In general, top layers are good high-amu filters for outgassing of underlying layers.***

***Low outgas top-coats can be very effective in reducing the resist related contamination.***



# ACKNOWLEDGEMENTS

N. Harned, C. Kaya, J. Steinhoff (ASML), E. Hendrickx, G. Vandenberghe, and K. Ronse (imec) for discussion and support in NXE outgas qualification.

R. Perera, and D. Houser (EUV Technology) for tool support.

T. Conard (imec) for XPS; W. Vansumere (imec) for help in pocket wafer development.

Hyun-Woo Kim (Samsung) for earlier investigation on topcoats (SPIE).

Material suppliers for help and discussion, in particular Nissan-Chemicals and Fuji-Film.

Part of this work was sponsored by the CATRENE program through the project CT30I EXEPT



**ASPIRE  
INVENT  
ACHIEVE**

