IMEC UPDATE ON RESIST OUTGASSING

I. Pollentier, E. Hendrickx

OUTLINE

NXE outgas qualification at imec

Correlation of NXE qualifications to RGA

Comparison of NXE qualifications to Film Thickness loss ?

Summary

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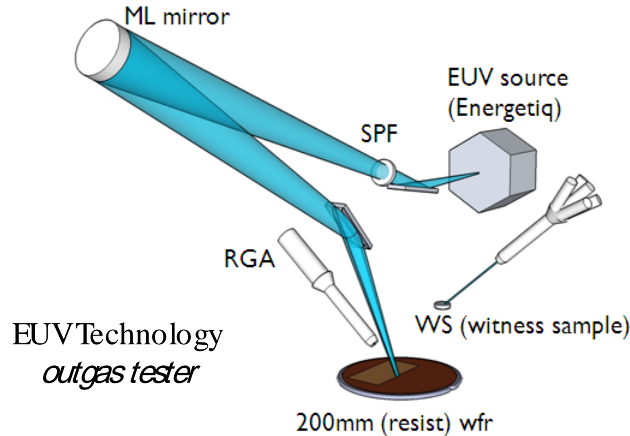
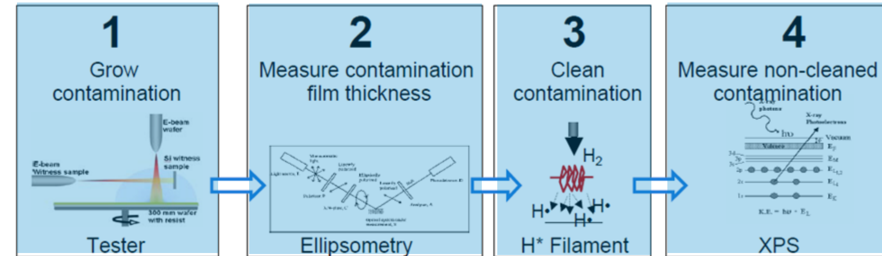
RESIST OUTGASSING QUALIFICATION PROCEDURE FOR NXE3X00

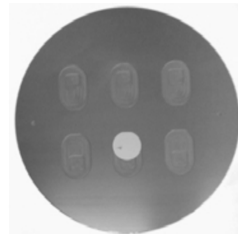


EUV Technology
outgas tester



Resist TWG meeting February 2013 :
NXE outgas qualification certified end H1'2012
107 materials were tested (69 customer samples)
Throughput : ~20 samples/month (XPS limited)

KLA-tencor UV1280 *ellipsometer*



200mm Pocket-wafer with 6 available positions for 1" WS

EUV Technology
H-filament cleaner

Thermo Instruments Theta 300
XPS

NXE OUTGAS QUALIFICATION AT IMEC

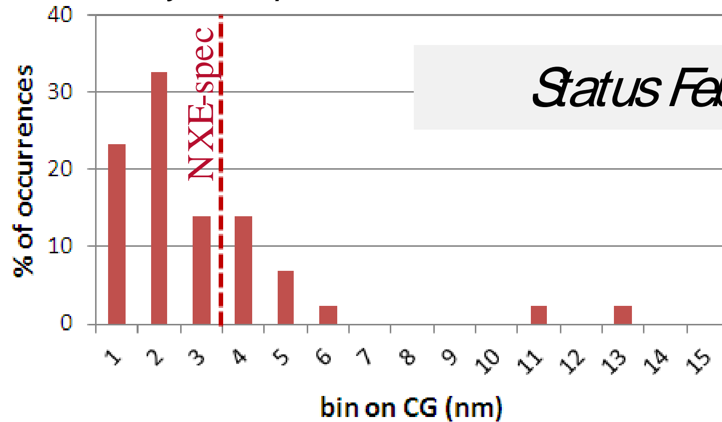
Outgas qualification at imec had several long tool down in last half year :

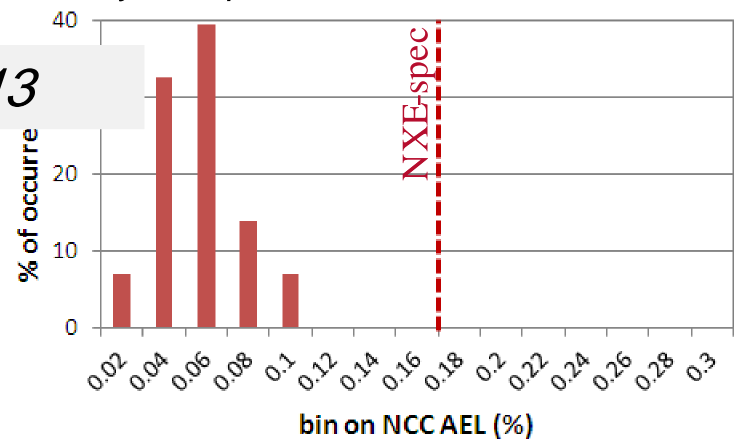
- March-April : wafer stage bearings X-movement
- May : re-certification (~3 weeks)
- July-August : wafer stage bearings X-movement
- September : re-certification ongoing – scan direction mostly in Y to limit strain on wafer stage bearings used in X-movement (containment)

Customer samples qualified in last half year : 21 (in total 90 customer samples are tested in imec so far)

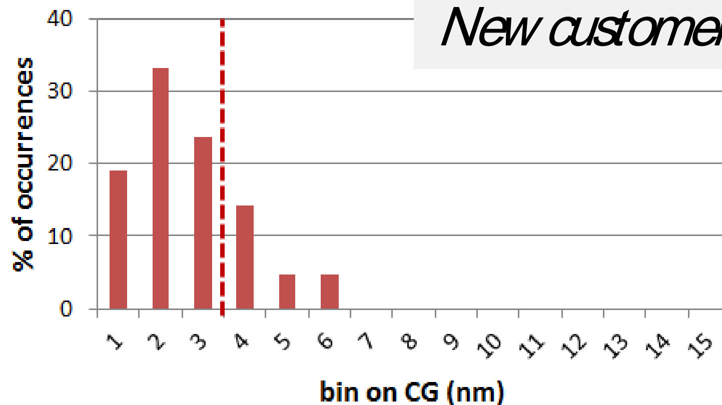
NXE OUTGAS QUALIFICATION AT IMEC

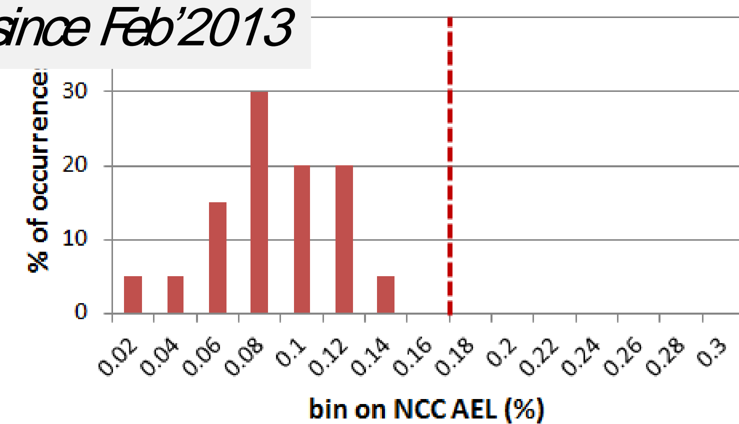
Status February 2013





New customer samples since Feb'2013





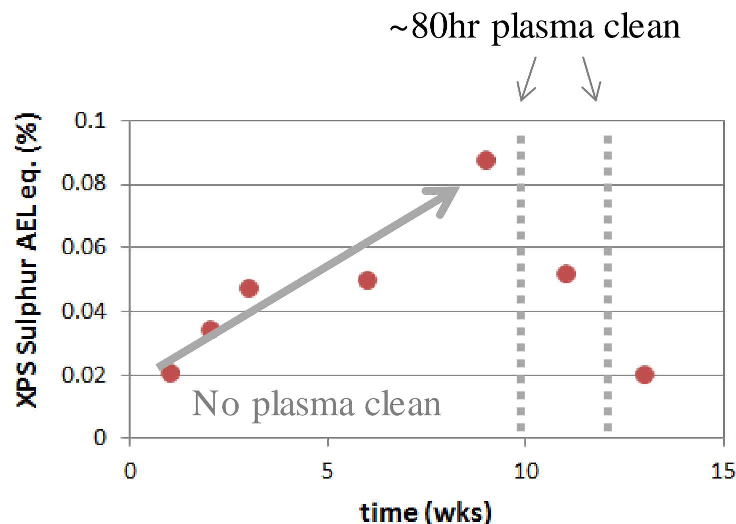
~75% of materials meet the spec for cleanable contamination (CG<3nm)

100% of materials meet the spec for non-cleanable contamination. Average increase of NCC is due to chamber background increase.

NXE OUTGAS QUALIFICATION AT IMEC

Non-cleanable contamination : Sulphur is main contributor

- During H*-cleaning operations of witness samples the sulphur contribution is continuously increasing (measured as tool background on WS w/o contamination)
- Periodic (& long) plasma clean can reduce the sulphur contribution significantly



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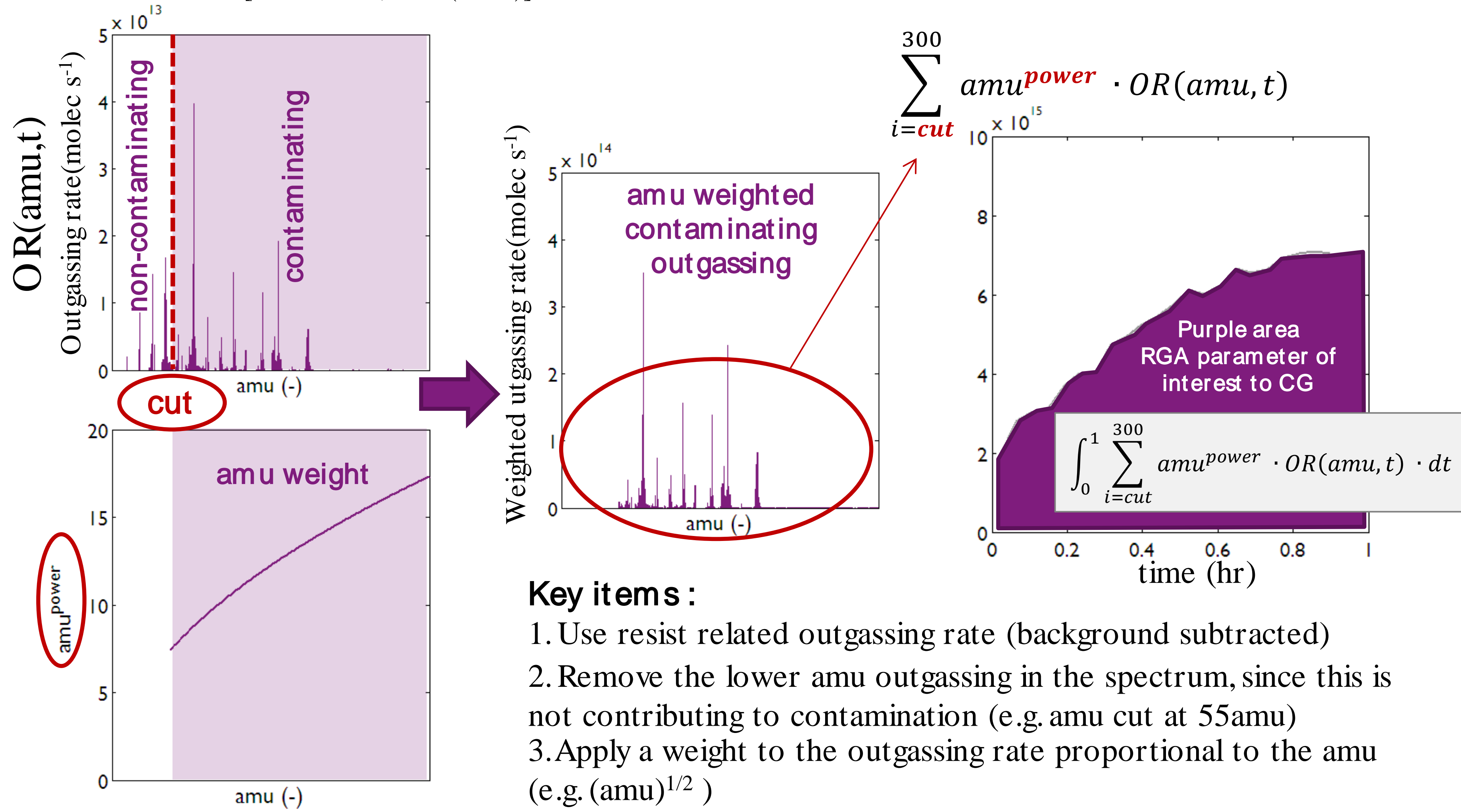
RGA FOR CONTAMINATION QUALIFICATION

[I. Pollentier, SPIE (2013)]



Key items :

1. Use resist related outgassing rate (background subtracted)
2. Remove the lower amu outgassing in the spectrum, since this is not contributing to contamination (e.g. amu cut at 55amu)
3. Apply a weight to the outgassing rate proportional to the amu (e.g. (amu)$^{1/2}$)
4. Measure and integrate this weighted outgassing during the time the WS is exposed

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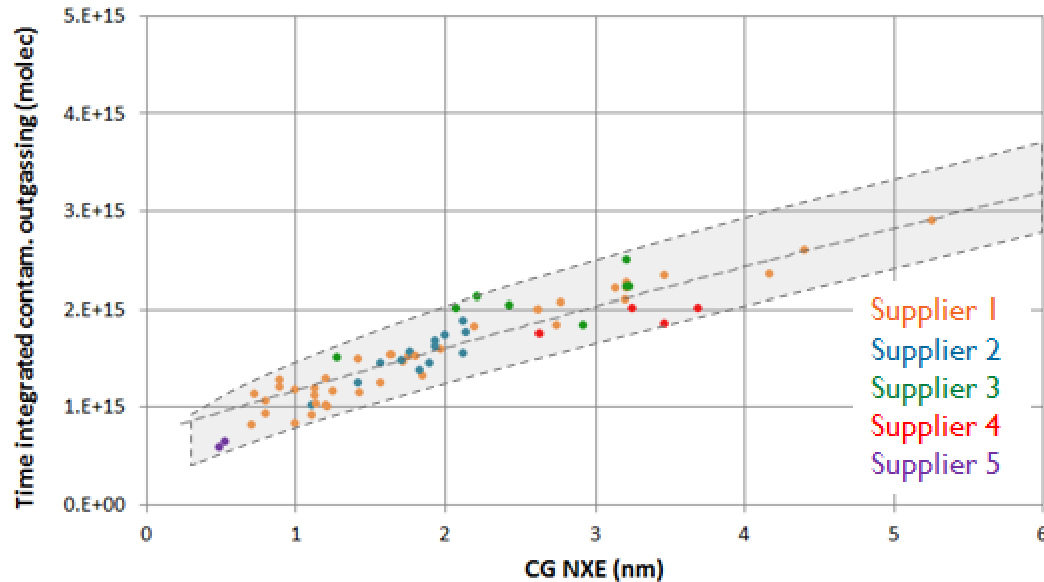
RGA FOR CONTAMINATION QUALIFICATION



- RGA-to-CG relationship holds for many resists (>50)
- Imec will investigate in what amount the (small) variations are significant (e.g. towards chemistry)
- Imec has no direct plans to use this for NXE outgas qualification (non-inspection of non-cleanable contamination), but RGA approach could be useful to understand differences in contamination results, e.g. round robin.

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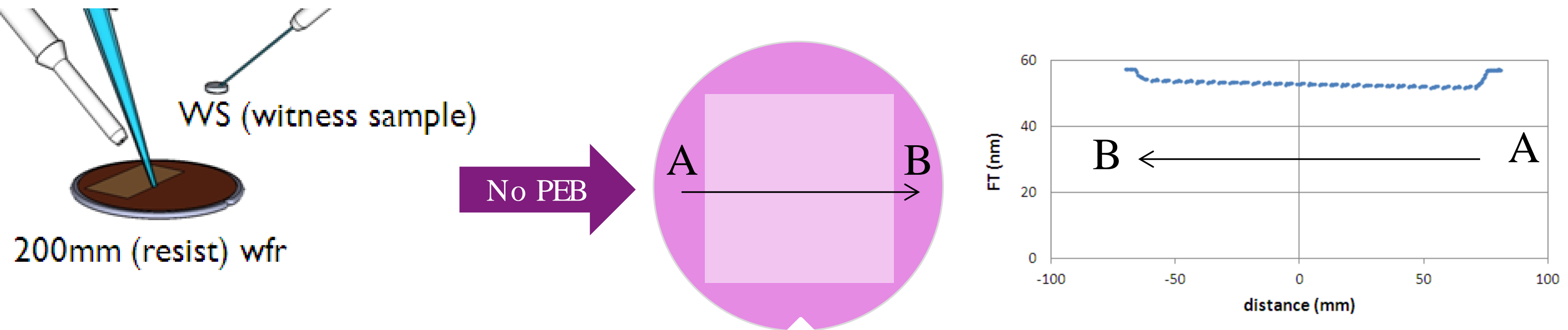
FILM THICKNESS LOSS AND OUTGASSING

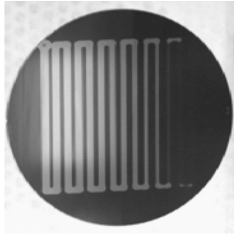
During outgas testing, the outgassing of species results in a film thickness (FT) loss of the exposed resist [K. Hoshiko, EUVL symp. Brussels (2012)]



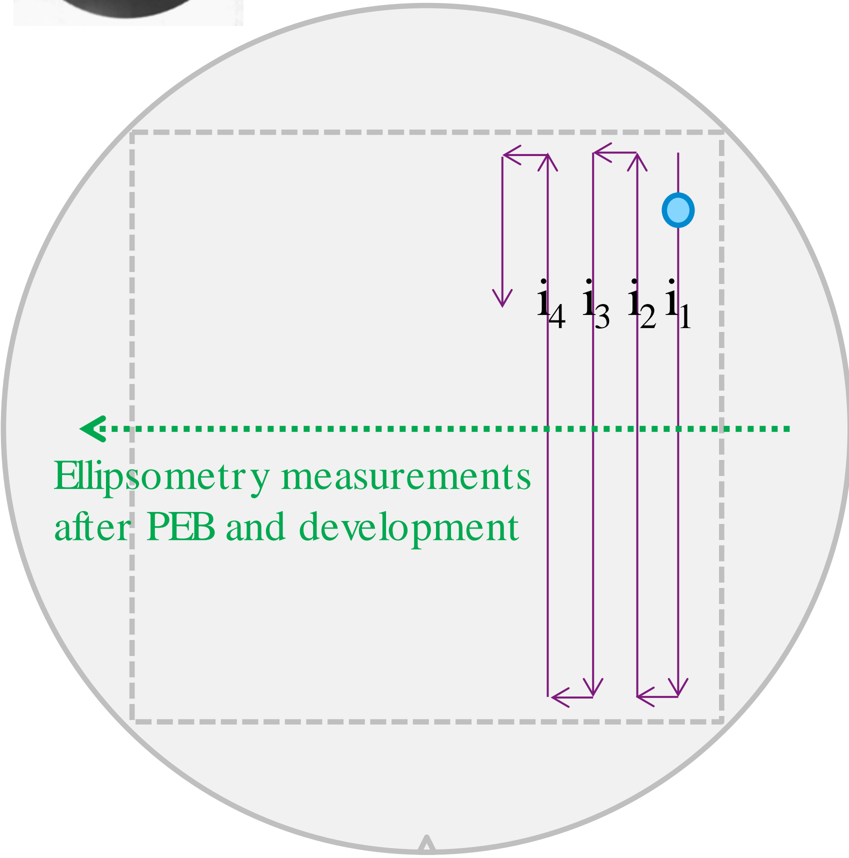
No good correlation with NXE CG contamination results :

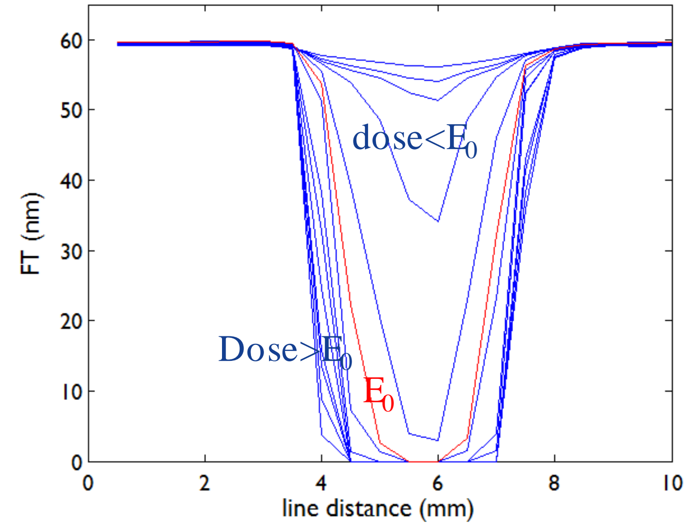
- Thickness loss is related to both contaminating and non-contaminating outgassing
- Thickness loss w/o PEB is delay sensitive (time between exposure and ellipsometer measurement)

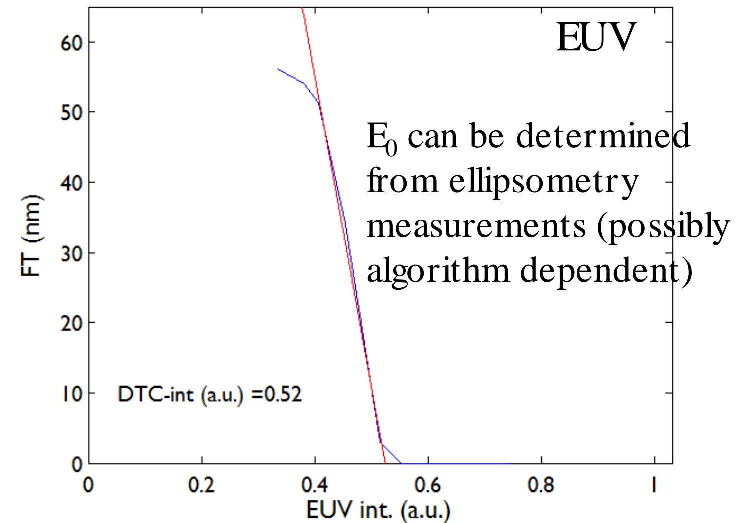
But the idea of FT loss might be useful for other investigation related to outgassing and contamination, e.g. E_0 ...



FILM THICKNESS LOSS FOR OUTGASSING COMPARISON







E_0 can be determined from ellipsometry measurements (possibly algorithm dependent)

E_0 testing by exposure in scanned line mode, with subsequent PEB and development

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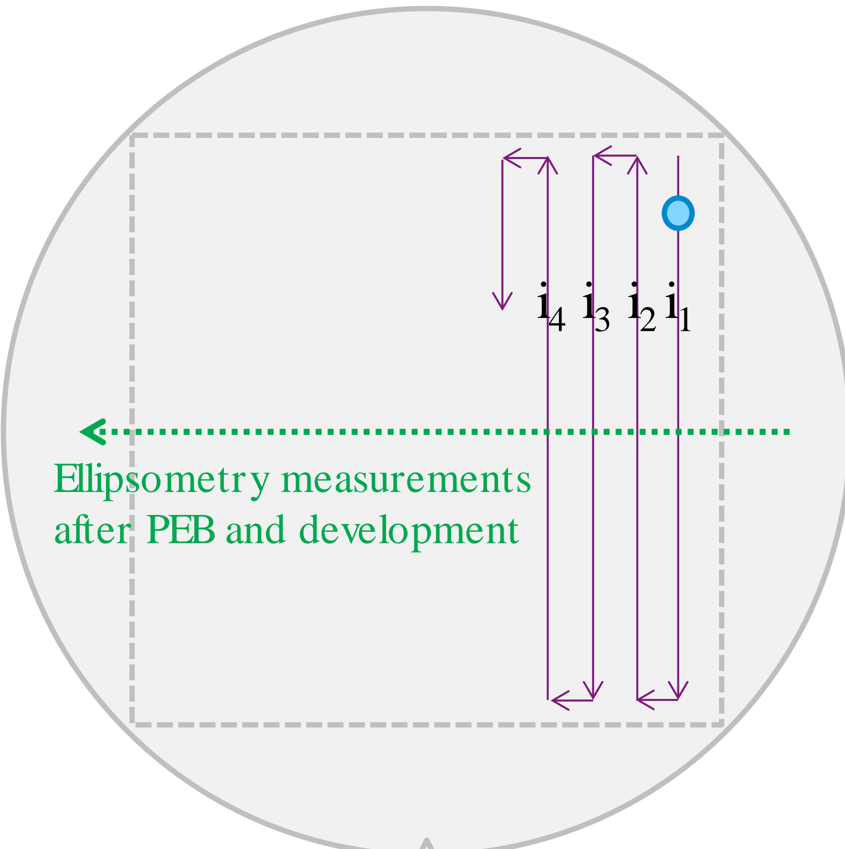
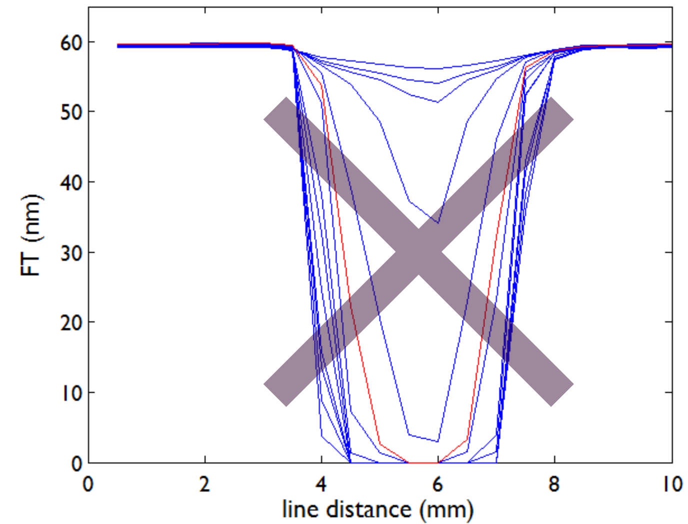
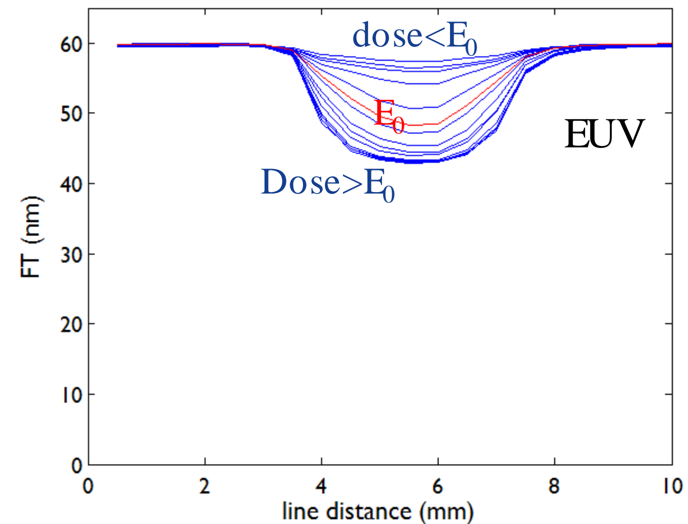
FILM THICKNESS MEASUREMENTS FOR OUTGASSING COMPARISON







E_0 testing by exposure in scanned line mode, **with subsequent PEB** (w/o development)

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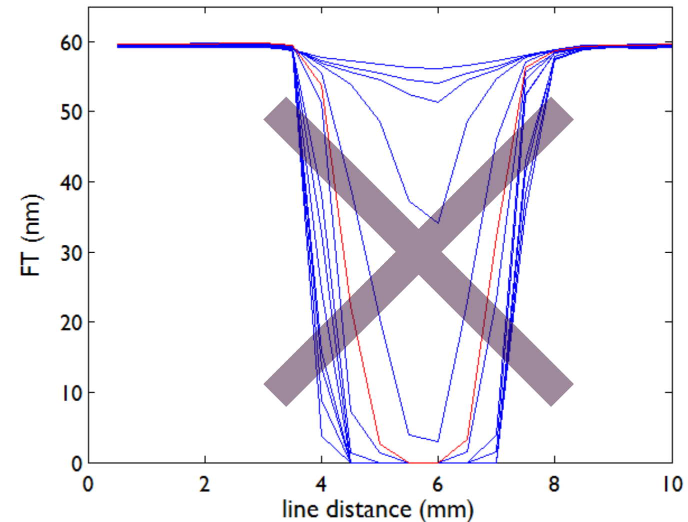
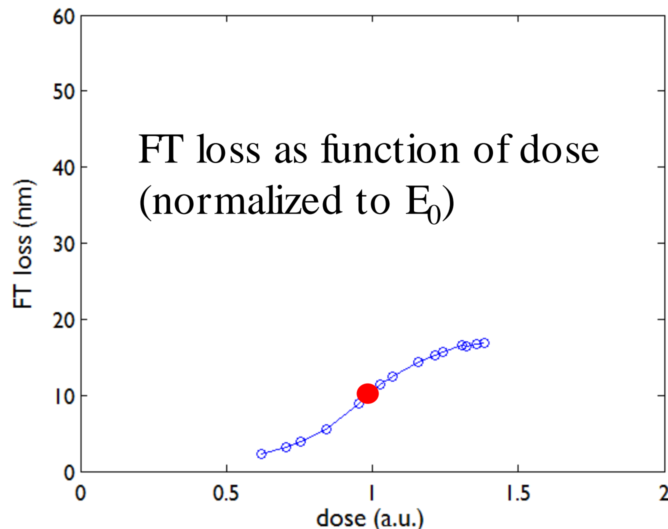
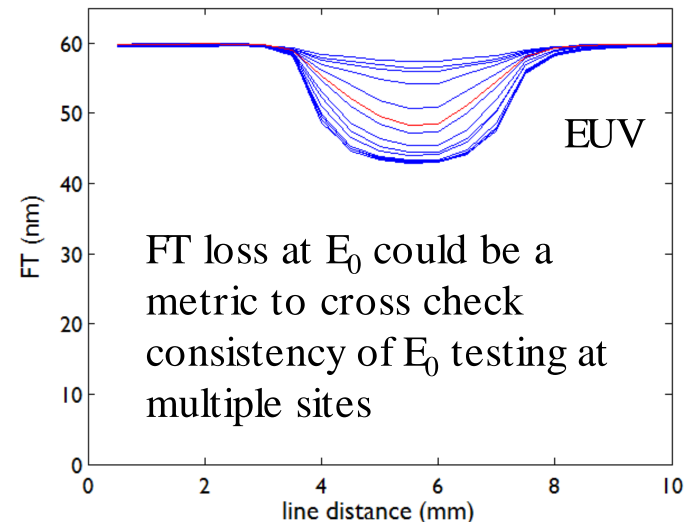
FILM THICKNESS MEASUREMENTS FOR OUTGASSING COMPARISON

E_0 testing by exposure in scanned line mode, **with subsequent PEB** (w/o development)







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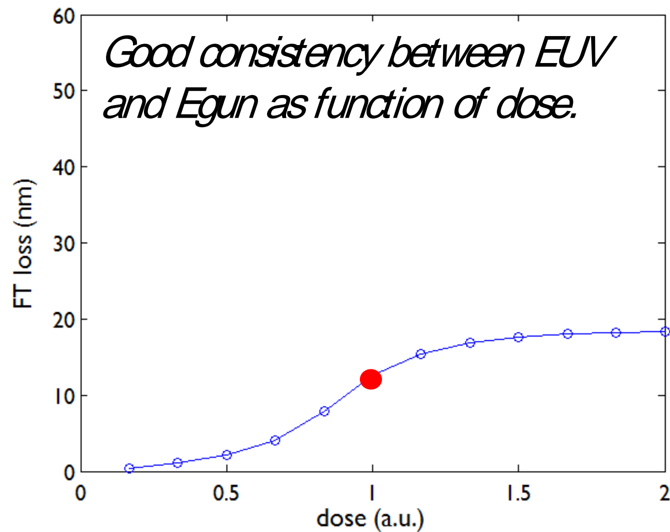

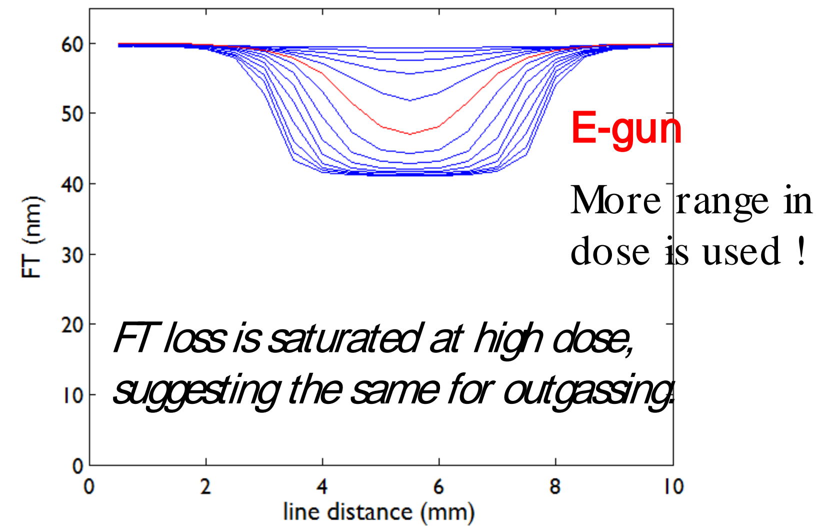

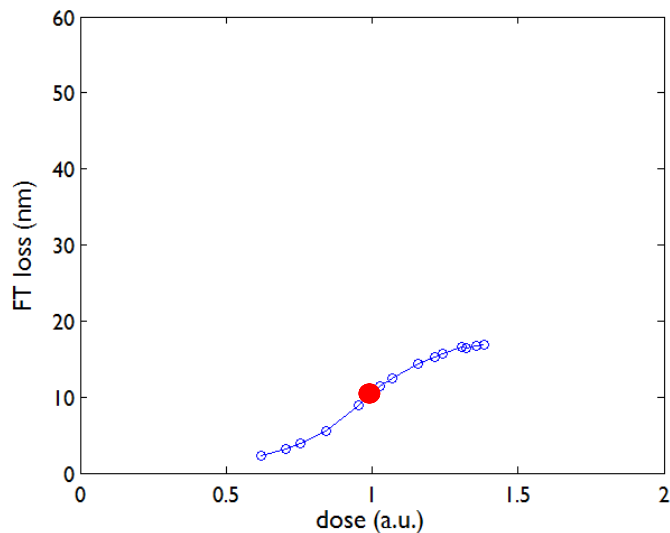

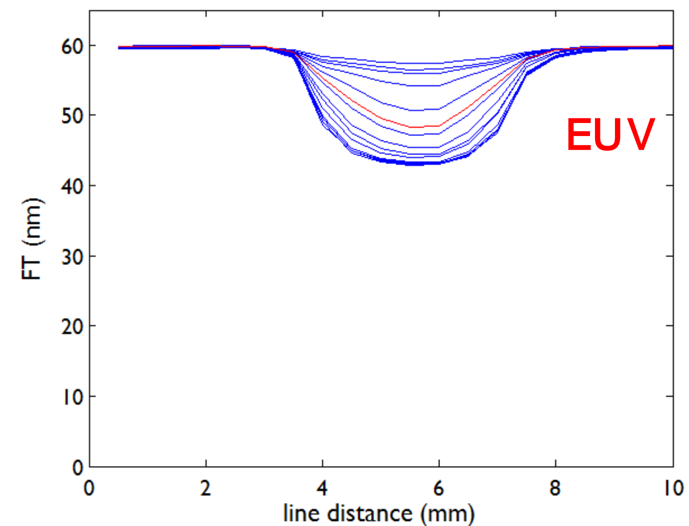

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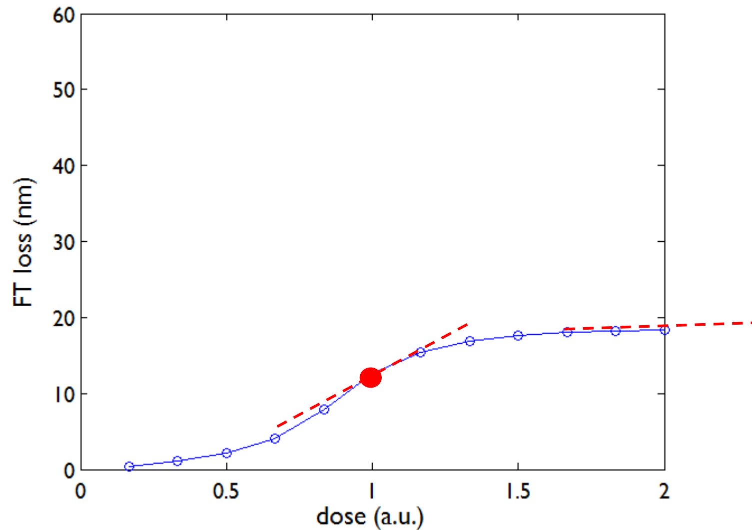

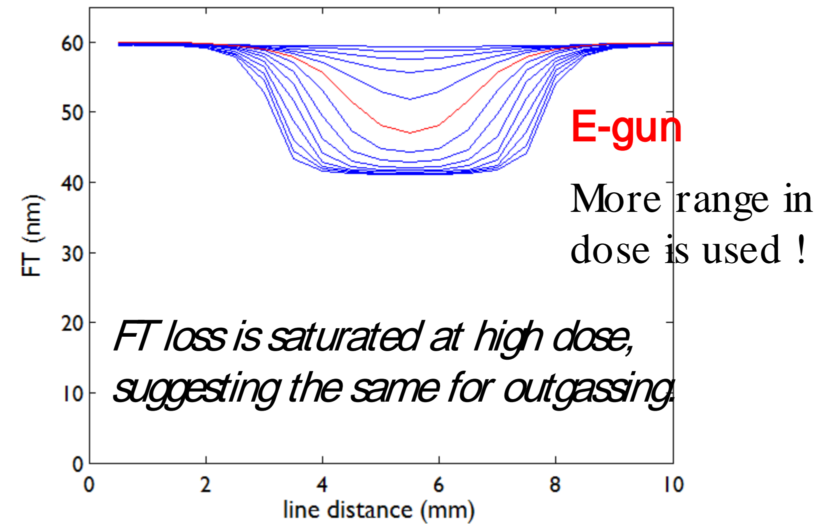

More range in dose is used !

FT loss is saturated at high dose, suggesting the same for outgassing

*Set point at E_0 seems most difficult towards variability with respect to dose setting error, 2*E_0 suggests better control of outgassing test result.*

More tests required (other resists and other PEB temperatures) ...

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Due to wafer stage issues in the outgas tester, limited outgas qualification have been done at imec.

For checking consistency of NXE outgas test results, RGA and FT measurement could be useful to identify the root cause of any differences.

ACKNOWLEDGEMENTS

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ACHIEVE

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