Resist Based Dose Calibrations Update

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Resist TWG, EUV 2008 Symposium

October 2, 2008

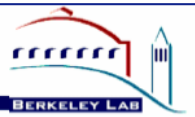
ASML has verified the parameters and assumptions for the Eo tests by LBNL and NIST

- In May 2008, LBNL and NIST reported on new Eo measurements for two resists: R&H TOK P1123 and (LBNL only) MET1K (XP4502-D)
- Metrology at both LBNL and NIST were reviewed by ASML and confirmed to be good
- As a result of the NIST and LBNL work, a 1.9x correction was determined as necessary for all METs as reported in May 2008

ASML

The results of the LBNL new E_0 measurements were presented in May 2008

E_0 measurement at BL6.3.2



- Two independent measurements of RHEM MET-1K and TOK EUVR-P1123 done, respectively

9/07	10/07
Beamline current ~20 mA	Beamline current ~250 mA
MET-1K: E_0 = 7.6 mJ/cm^2 PAB 130/60, PEB 120/90, Dev 45s	MET-1K: E_0 = 7.3 mJ/cm^2 PAB 130/60, PEB 120/90, Dev 45s
P1123: E_0 = 5.6 mJ/cm^2 PAB 120/90, PEB 100/90, Dev 60s	P1123: E_0 = 6.0 mJ/cm^2 PAB 120/90, PEB 100/90, Dev 60s

Average E_0

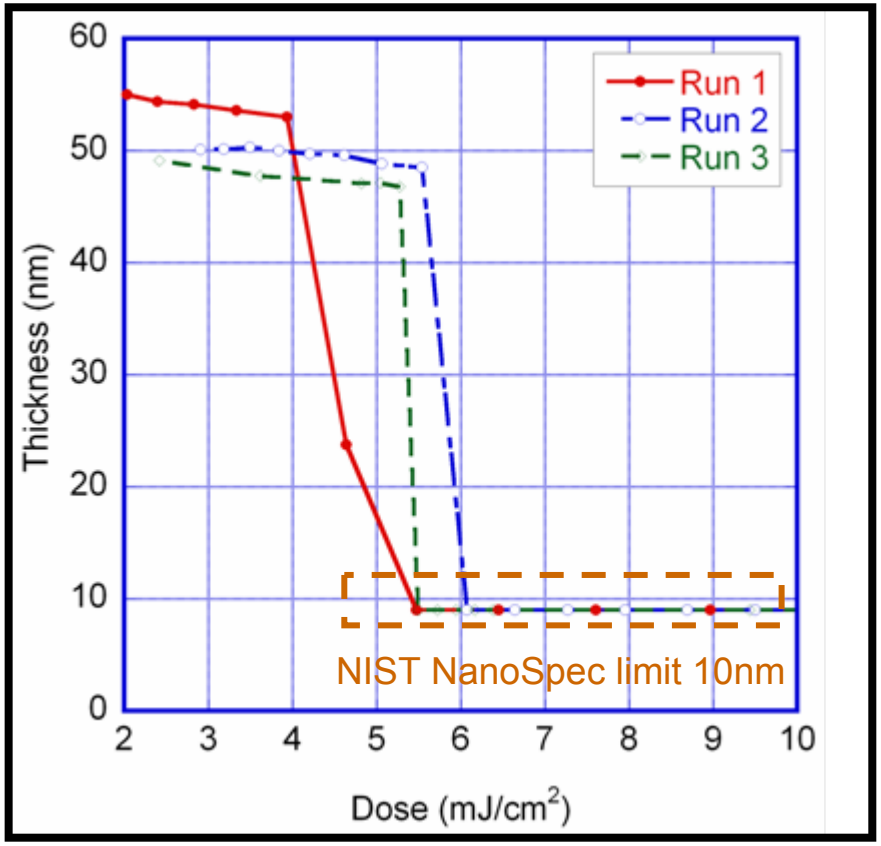
MET-1K: 7.45 mJ/cm^2 **P1123: 5.8 mJ/cm^2**

Patrick Naulleau 11

XP4502-D Note that ASML uses XP4502-J

NIST reported results in May 2008 showing a match to the LBNL results

NIST Results (Resist B)



PEB Delay ~ 20min

Run	NIST E_0 (mJ/cm²)	Intel MET E_0/1.9 (mJ/cm²)
1	5.72	6.30
2	6.33	6.58
3	5.75	-
Avg	5.9	6.44

Resist B = TOK P1123

ASML

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- Metrology at both LBNL and NIST were reviewed by ASML and confirmed to be good
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ASML

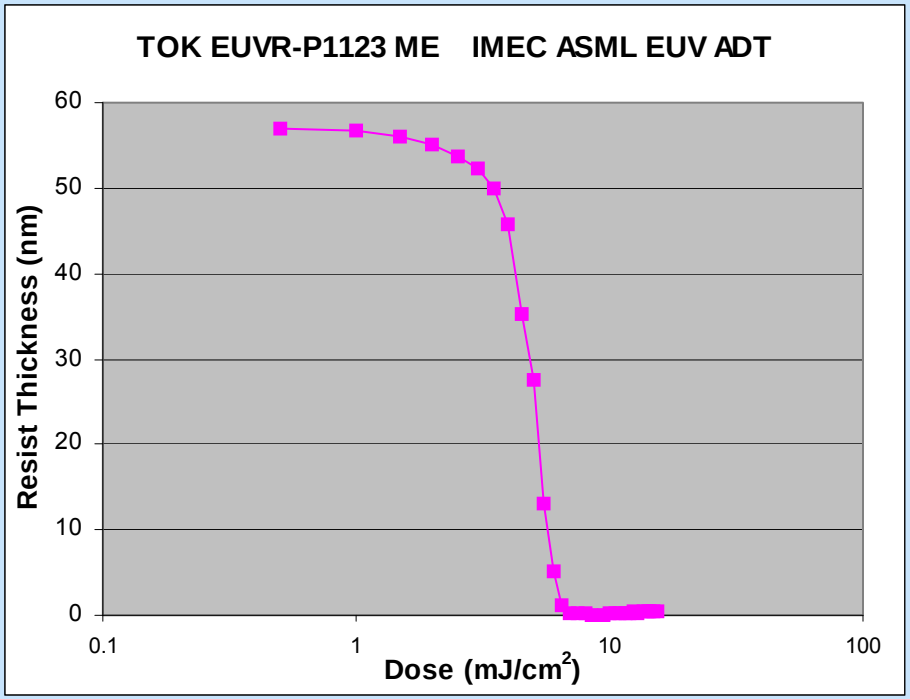
Data has been collected that confirms the ADT calibration as matching the NIST calibration

- Resist Eo has been checked on the ADT and compared to NIST and MET data
- Results confirm that the ADT matches the NIST calibration within uncertainty limits
  - Resist variation and processing differences were identified
  - All tools (METs, NIST and ADTs) use different processing (eg baking – contact vs. proximity)
- The next sheet shows results as tested by Intel, confirming that between NIST, MET and ADT, the TOK P1123 Eo data matches
- In addition, NIST has measured for ASML two additional resists, providing additional confirmation that all results are in agreement

ASML

TOK EUVR-P1123 ME E0 Data
IMEC ASML EUV ADT

Friday July 25th, 2008
IMEC ADT
E0 for EUVR-P1123 ME **6.2 mJ/cm²**



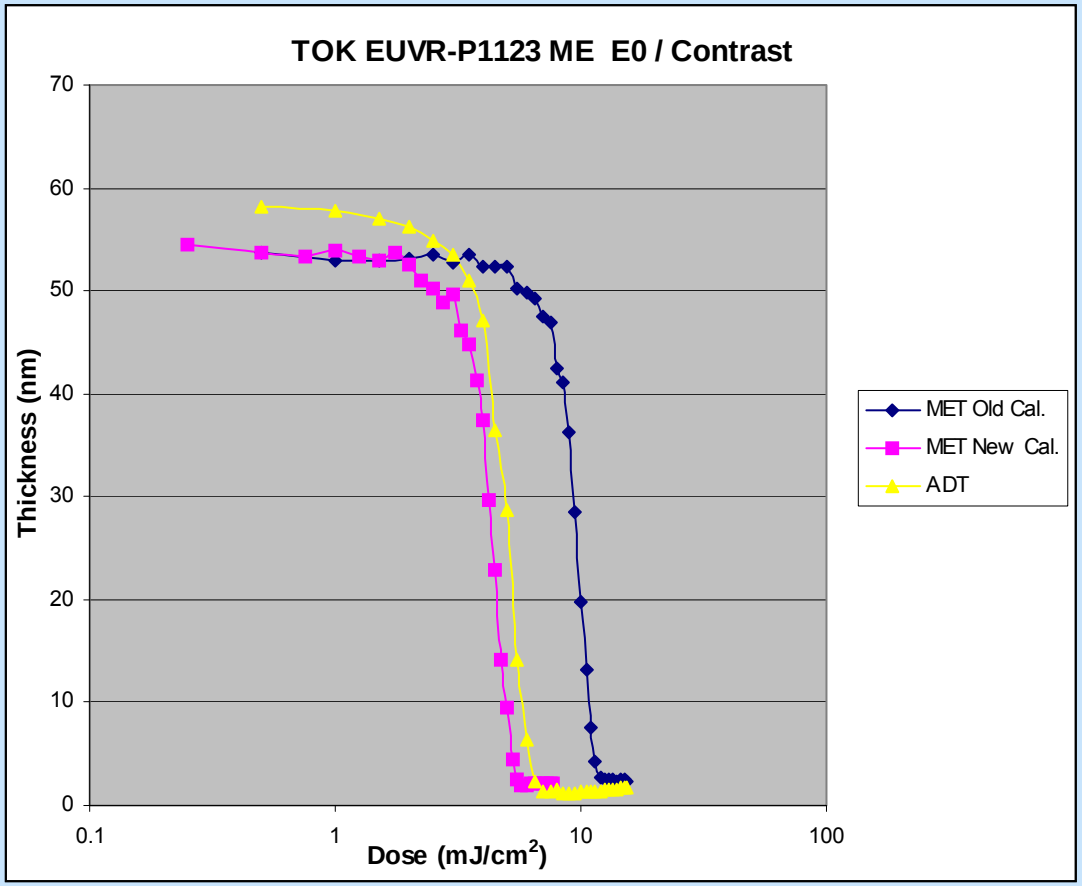
Previously published resist calibrations:

IEUVI Resist TWG (SPIE Feb. 2008)
LBNL BL6.3 (with calibrated photodiode)
'New' E0 for EUVR-P1123 ME **5.8 mJ/cm²**
(ave. of two measurements one month apart:
5.6 mJ/cm² and 6.0 mJ/cm²)

Sematech Litho Forum (May 2008)
NIST SURFIII (with calibrated photodiode)
E0 for EUVR-P1123 ME **5.9 mJ/cm²**

Conclusion: IMEC ASML EUV ADT matches 'new' EUV resist calibration standards
(or is at least very close... ≈ 6% high)

TOK EUVR-P1123 ME
IMEC ADT Comparison to Intel MET



MET old Calibration E0 ≈ 12.5mJ/cm^2

MET new calibration E0 ≈ 5.75 mJ/cm^2

ADT E0 ≈ 6.2 mJ/cm^2 (≈8% higher then MET new calibration)

Data has been collected that confirms the ADT calibration as matching the NIST calibration

- Resists have been checked on the ADT and Eo compared to NIST and MET data, and the results confirm that the ADT matches the NIST calibration within the uncertainty limits
  - Resist variation and processing differences were identified
  - All METs and NIST and ADTs use different processing (eg baking – contact vs. proximity)
- The next sheet shows results as tested by Intel, confirming that between NIST, MET and ADT, the TOK P1123 Eo data matches
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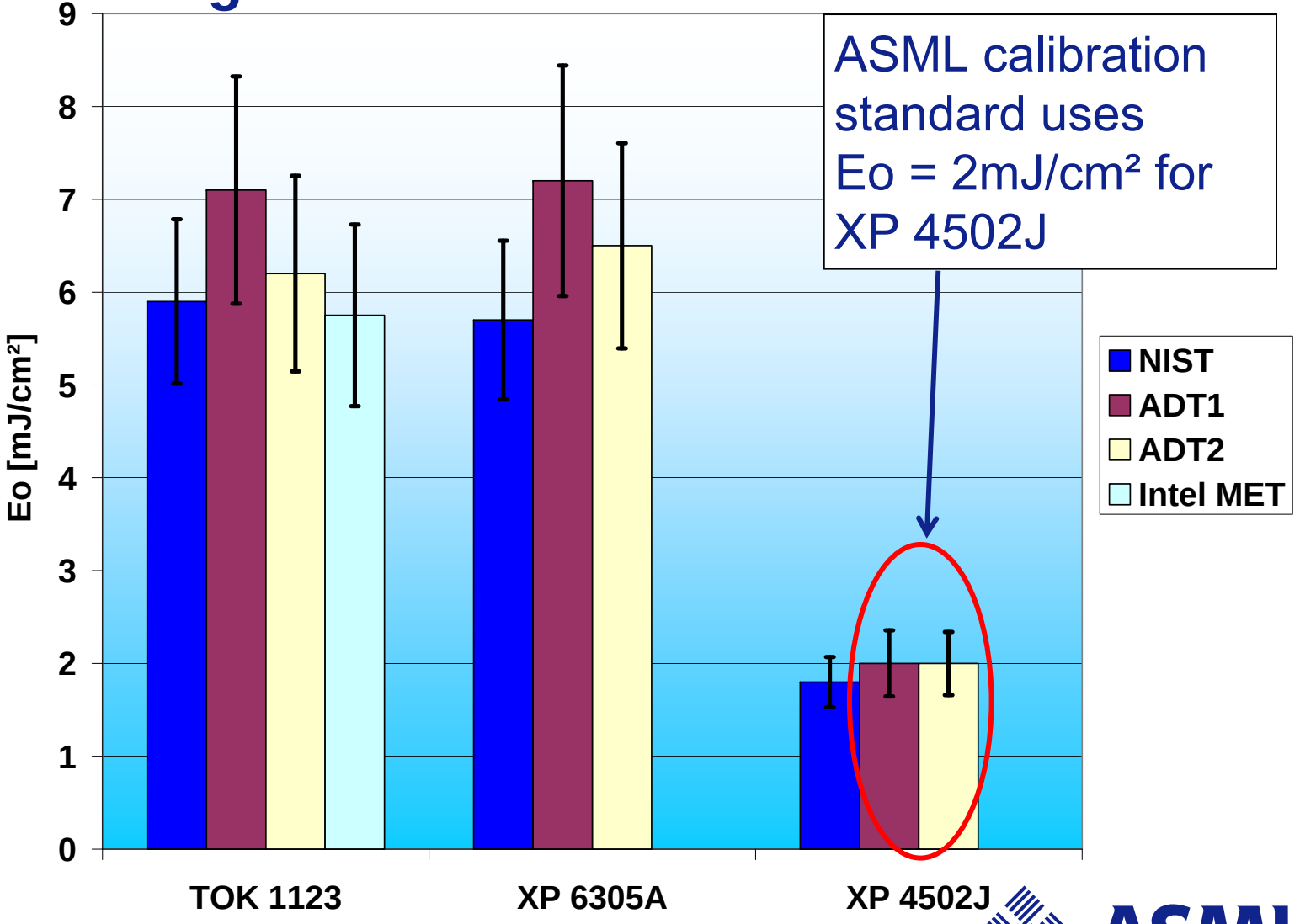
Estimated uncertainty factors influence resist based dose calibration

Component	Sub Component	NIST [± %]	ASML [± %]
Exposure Tool	Radiometry | Dose Performance	3	5
	Spectral power stability (DUV)	-	10
Resist	Resist contrast (dE/dFT)	10	10
	Unexposed resist loss		
	Measurement accuracy		
	Batch stabilty	5	5
	Process (SB, PEB, dev)	10	5
	Process variation (Difference)	-	5
Total Variation		15	17

ASML

Three resists have been tested confirming ADT matching to NIST calibration



Summary

- ASML uses resist based dose calibration to set up the ADTs
  - XP4502-J; Eo = 2 mJ/cm² is the calibration resist
- METs match NIST dose calibration after calibration correction of 1.9x
- ADTs match NIST dose calibrations without corrections
  - Source output and optical efficiency for ADT, and also machine process and methodology for calibration, are correct
  - Throughput and dose as reported previously are correct
- Both ADT and MET can be used for resist work, knowing that calibrations match within the uncertainties of using resist for calibration, but…..
- ***Industry needs a sensor that can be used on HVM EUVL systems for dose calibration***

ASML