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Study on De-protection Reaction Analysis System for EUV Lithography

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A. Sekiguchi, Y. Kono

Litho Tech Japan Corporation

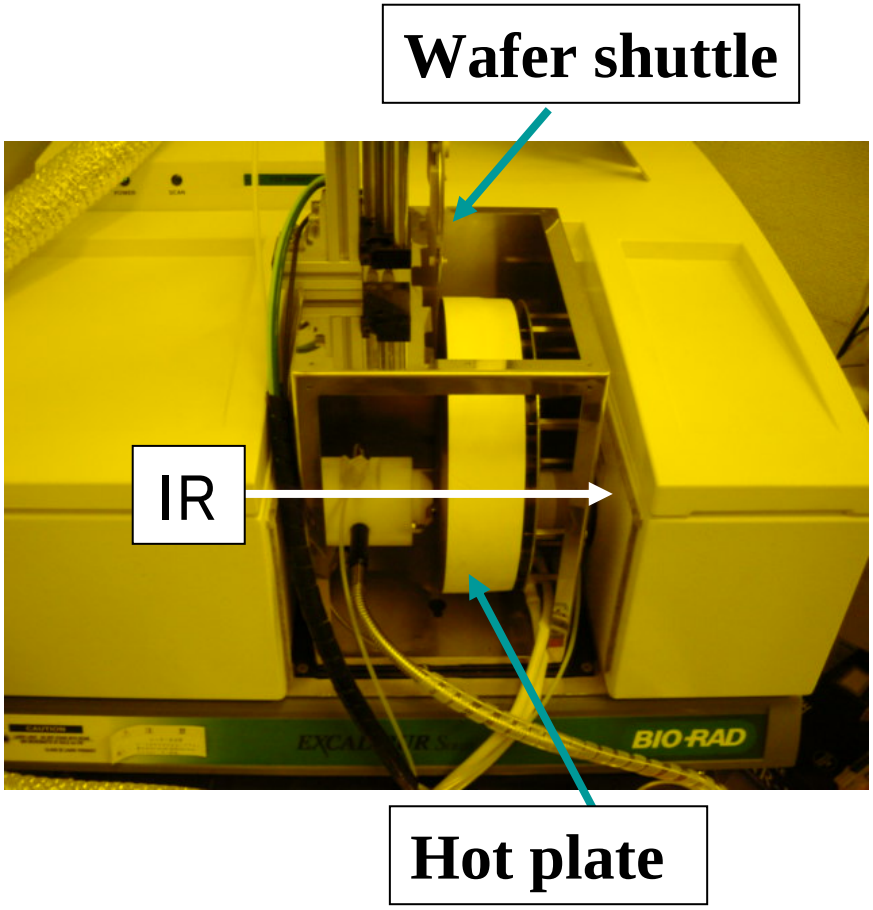
Outline

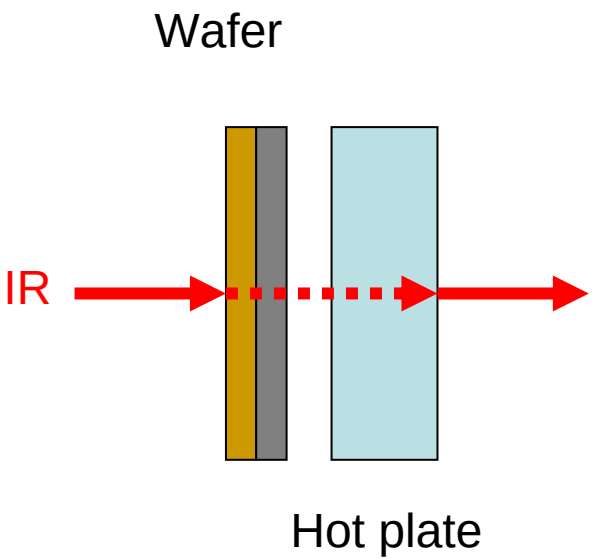
1. Introduction
2. The construction of the system
3. Experiment and result
4. Conclusion

Introduction

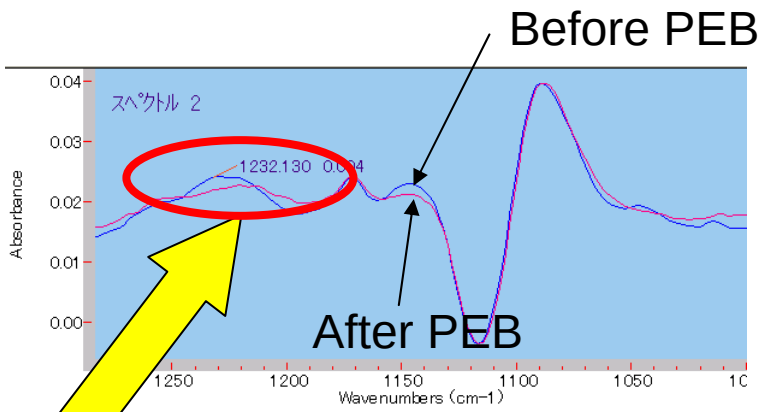
We are developing the FT-IR equipment for de-protection reaction analysis.
150nm of film thickness of conventional equipment was limits.
Then, IR light devised the equipment which enters at the angle of 45 deg to a wafer.
It turned out that a de-protection reaction can also observe the super-thin film sample of 25nm of film thickness by using this equipment.
EUVL requires ultra thin film of resist. I think that EUV resist research is attained by using this equipment.

The conventional system

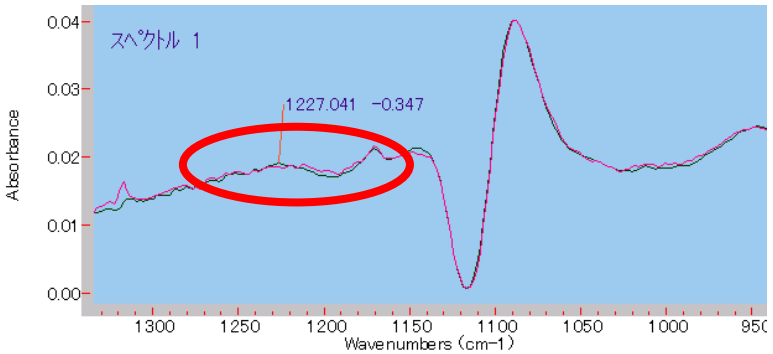




De-protection reaction analysis system PAGA-100

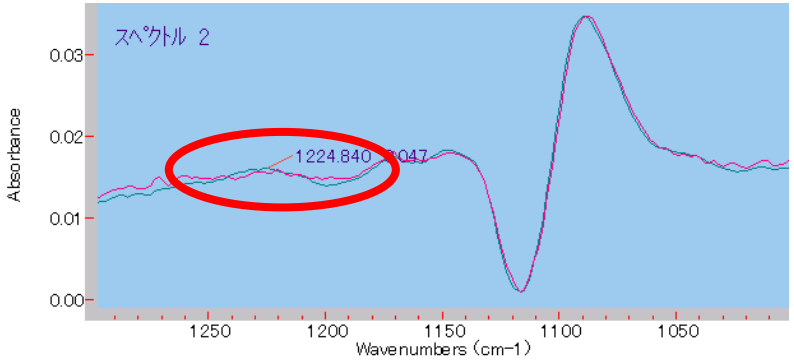


(a) 200nm



(b) 100nm

Limit of thickness



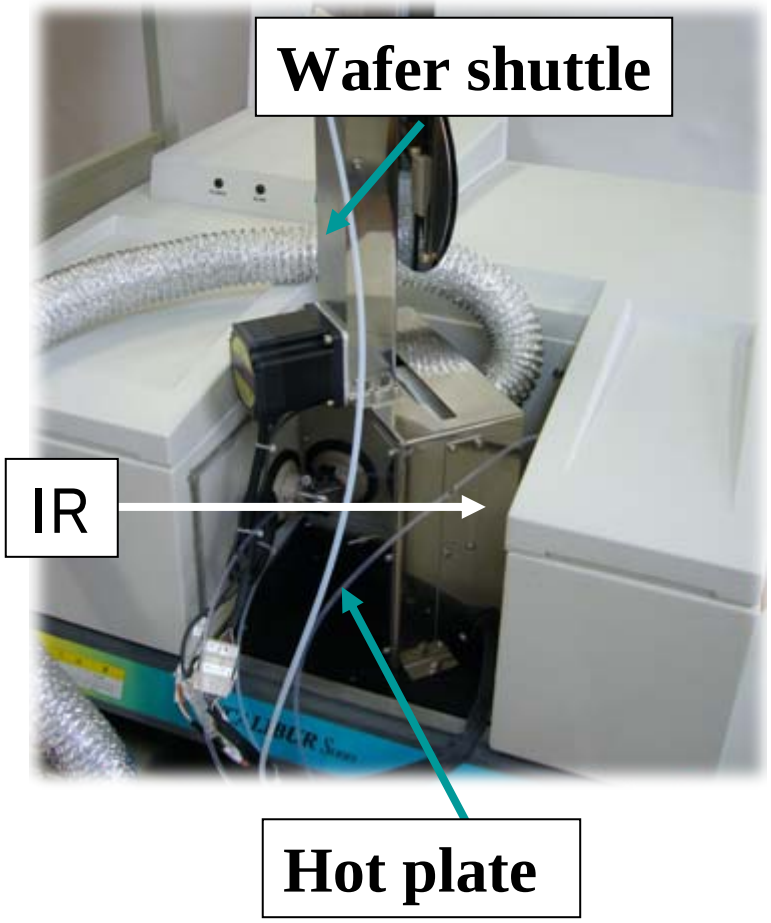
(c) 75nm

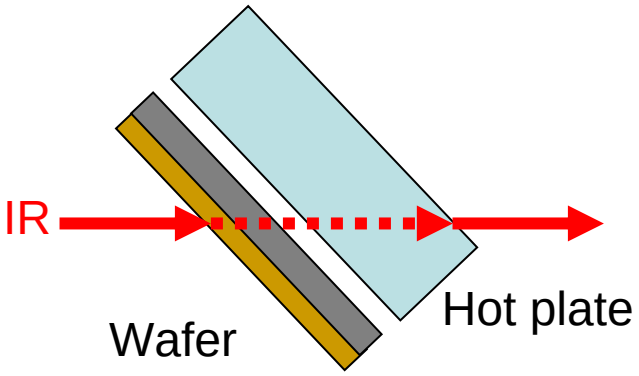
Relationship between resist thickness and IR Spectra

by using conventional method

KrF Resist/10mJ/cm²

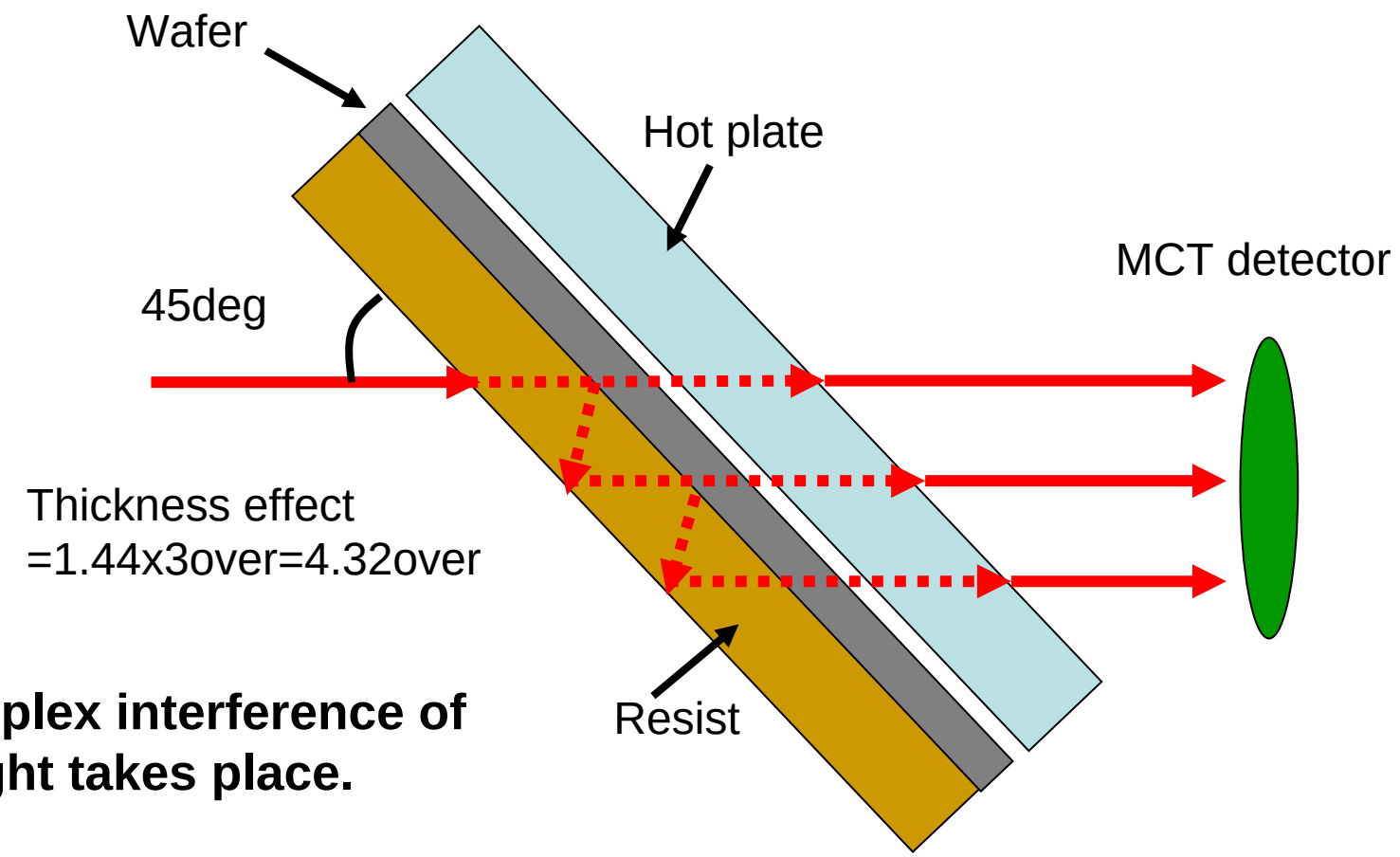
The new method system





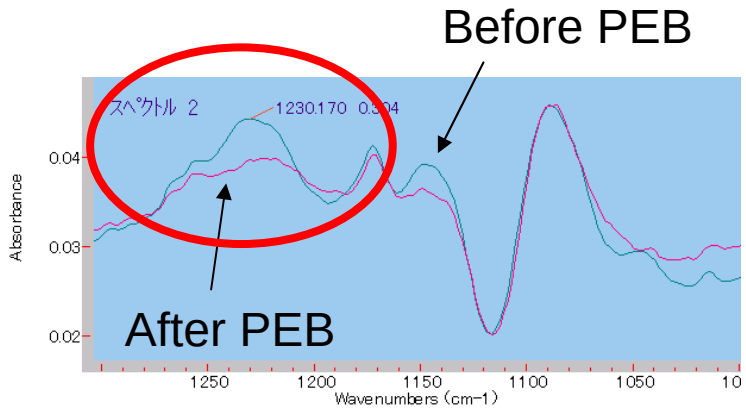
De-protection reaction analysis system PAGA-100EUV

The new method system

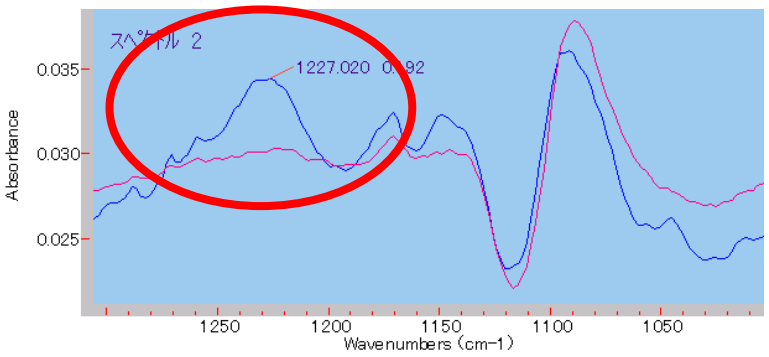


Multiplex interference of IR light takes place.

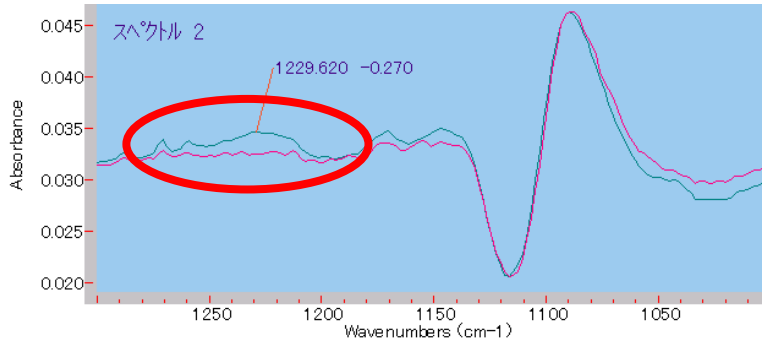
De-protection reaction analysis system PAGA-100EUV



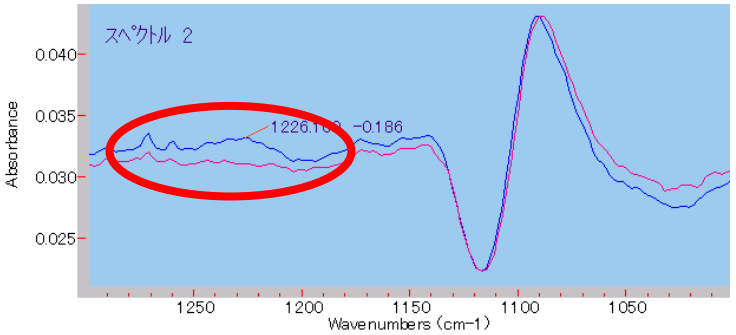
(a) 200nm



(b) 100nm



(c) 50nm



(d) 25nm

Relationship between resist thickness and IR Spectra by using new method

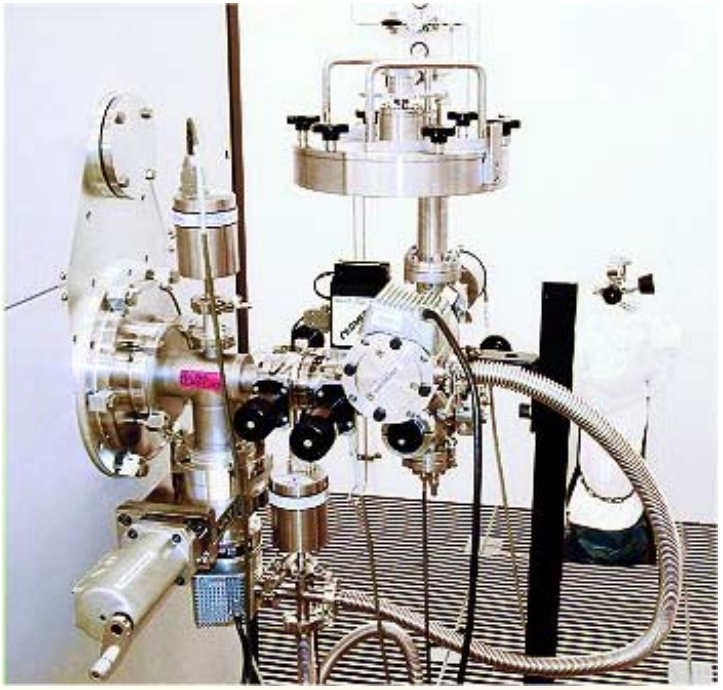
KrF Resist/10mJ/cm^2

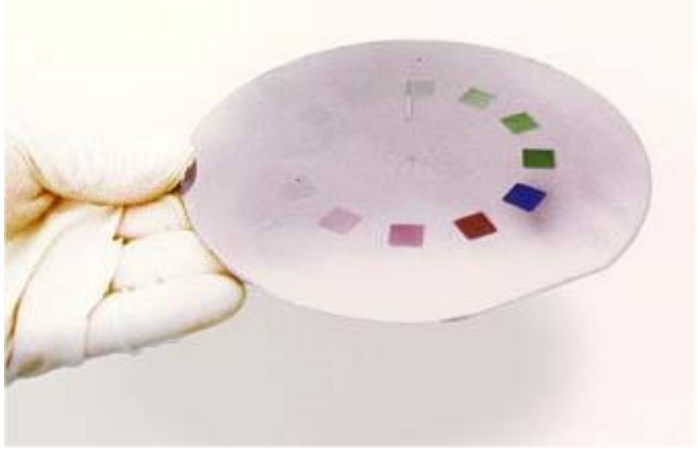
Litho Tech Japan

Experiment and result

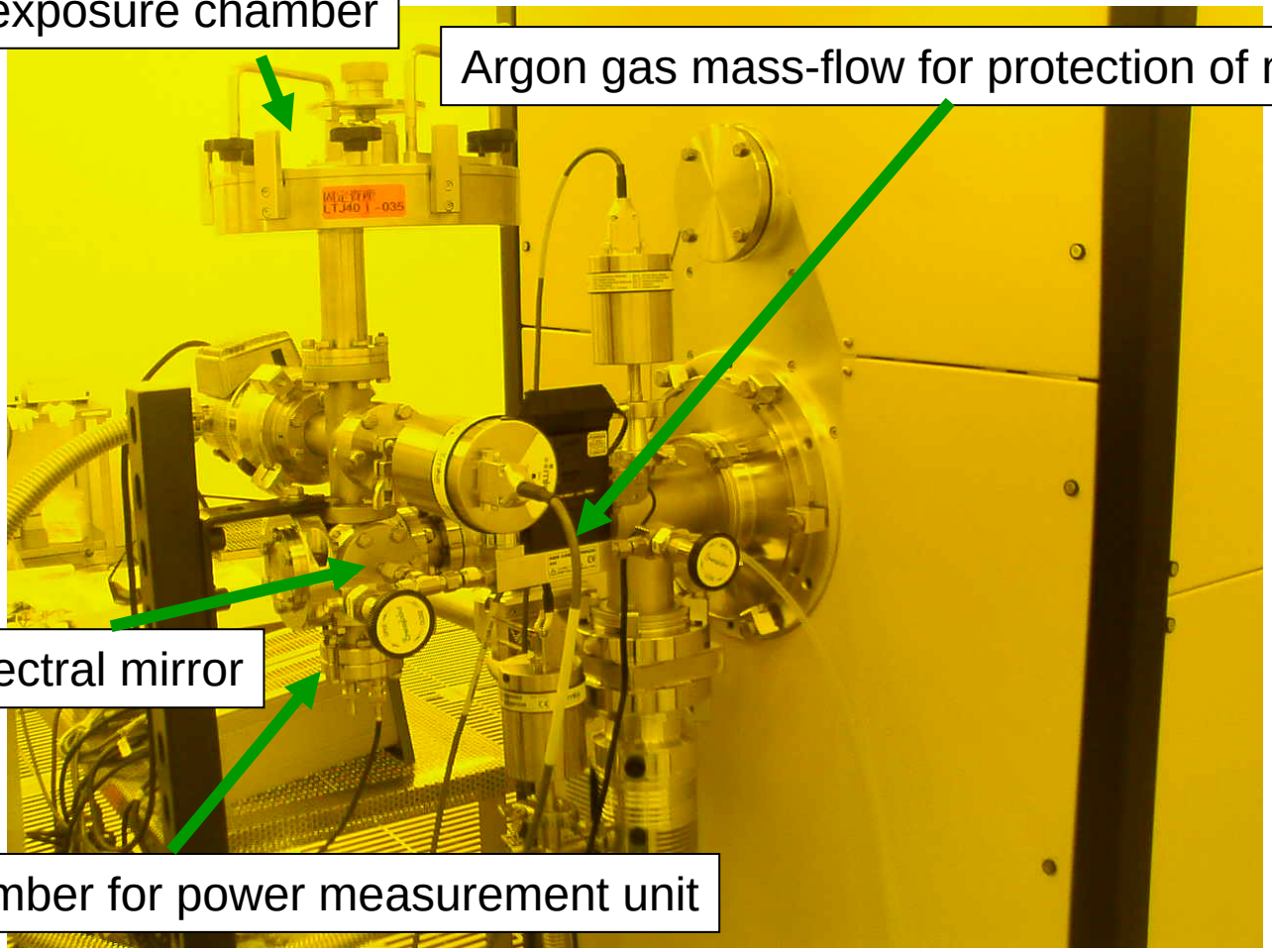
	Ven-dor	Thickness (nm)	PAB		PEB		Exposure (mJ/cm2)
			Temperature (deg. C)	Time (s)	Temperature (deg. C)	Time (s)	
TDUR-P036	TOK	100	90	90	110	90	10
MET-1K	R&H	125	130	60	110	90	16
MET-2D	R&H	125	130	60	110	90	16

EUV open frame exposure system EUVES-7000

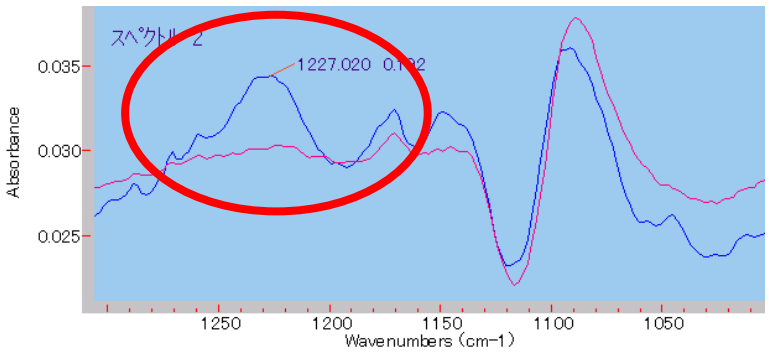




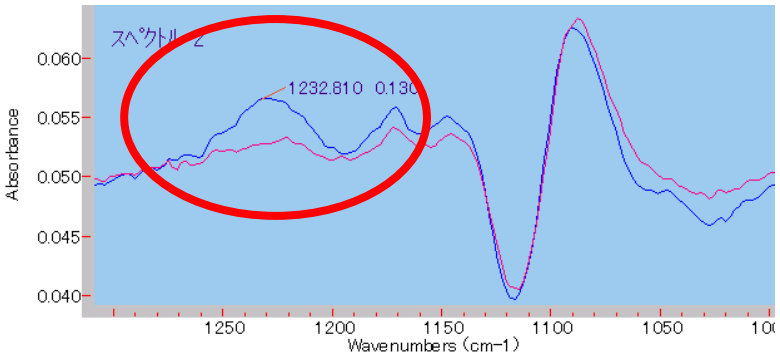
EUV open frame exposure system EUVES-7000



Experiment and result



(a) 248nm exposure



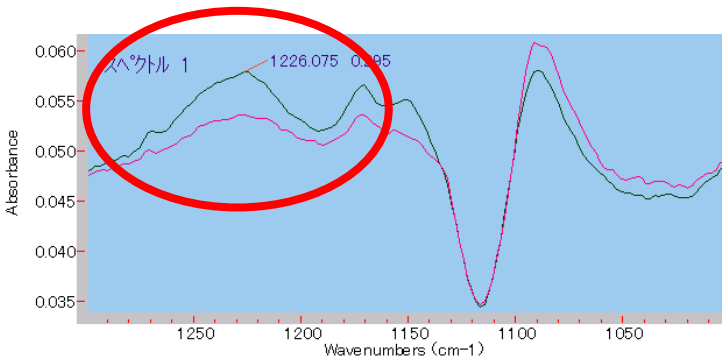
(b) EUV exposure

Comparison of light source and IR Spectra

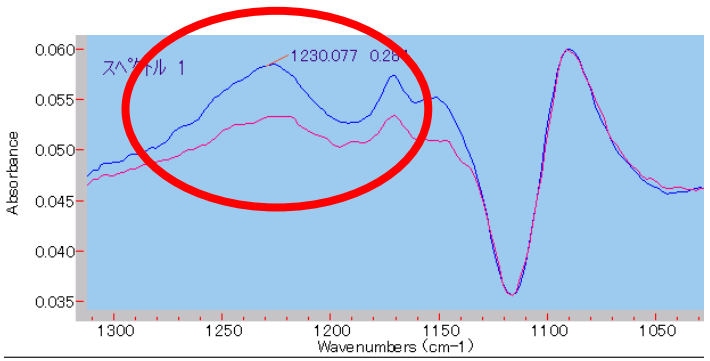
by using new method

KrF Resist/10mJ/cm^2

Experiment and result



(a) MET-1K



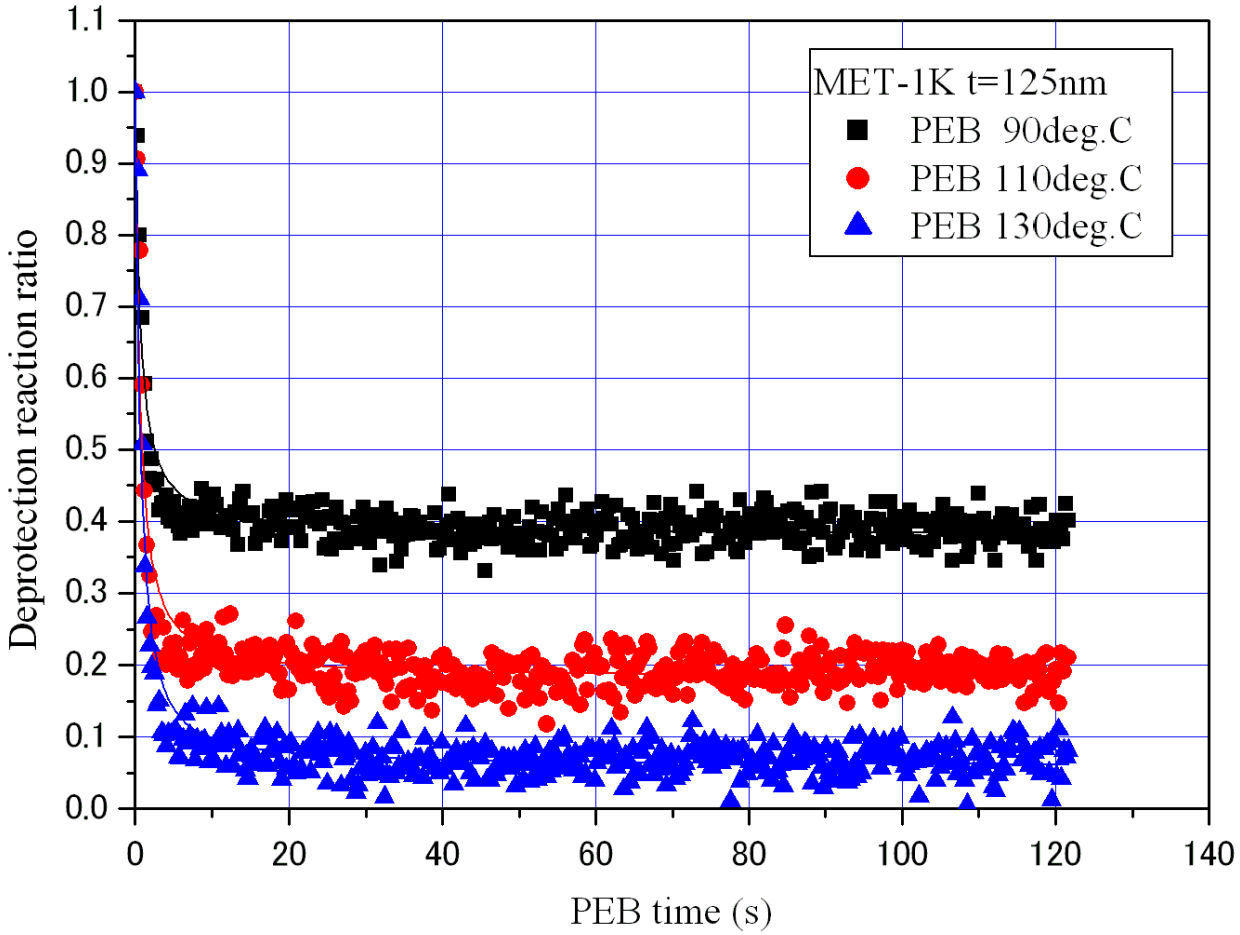
(b) MET-2D

Comparison of different EUV resist and IR Spectra

by using new method

EUV Resist/t=125nm/PEB=90deg.C/EUV=16mJ/cm^2

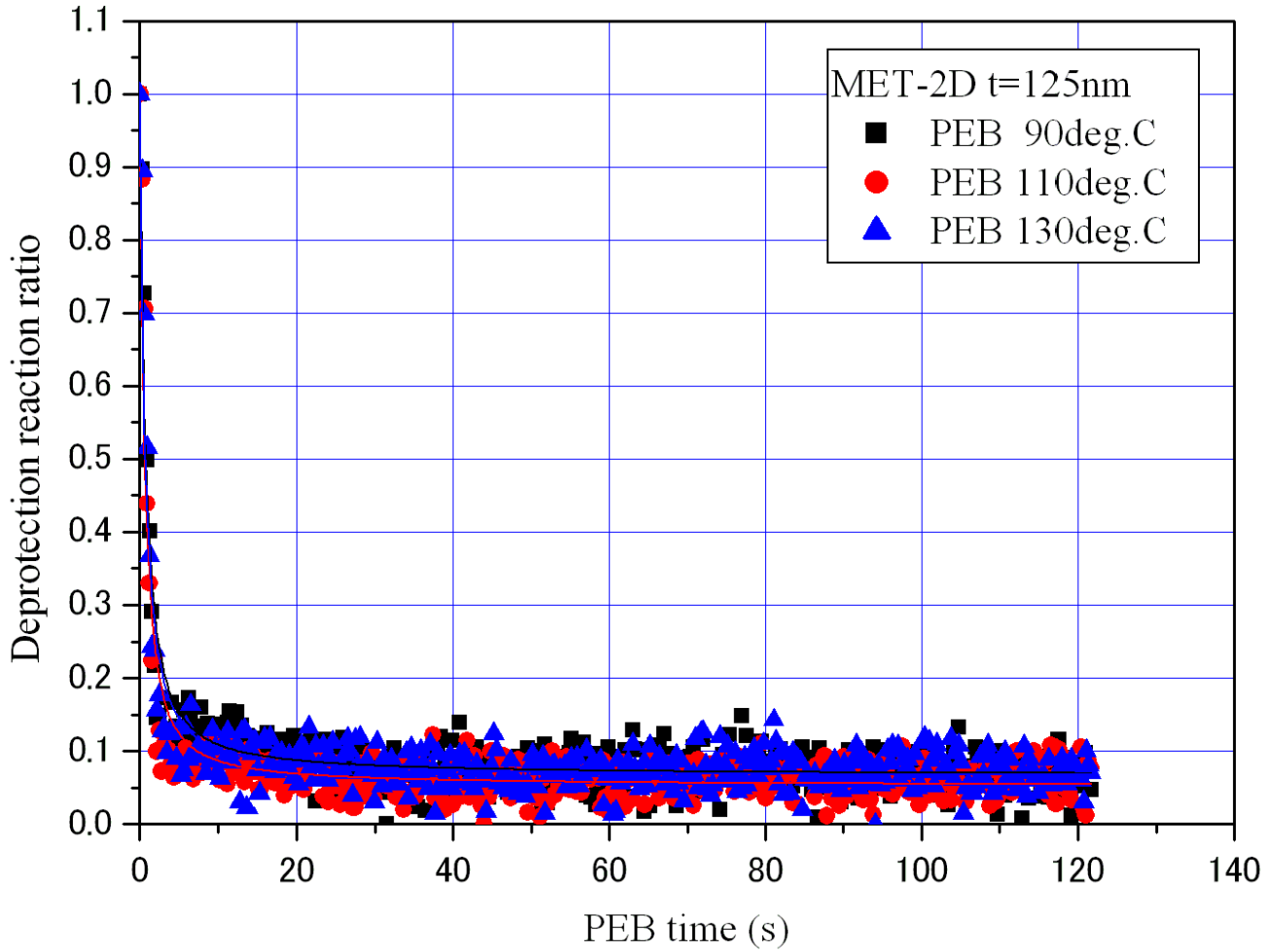
Experiment and result



Deprotection reaction and PEB time at different PEB temperature

MET-1K

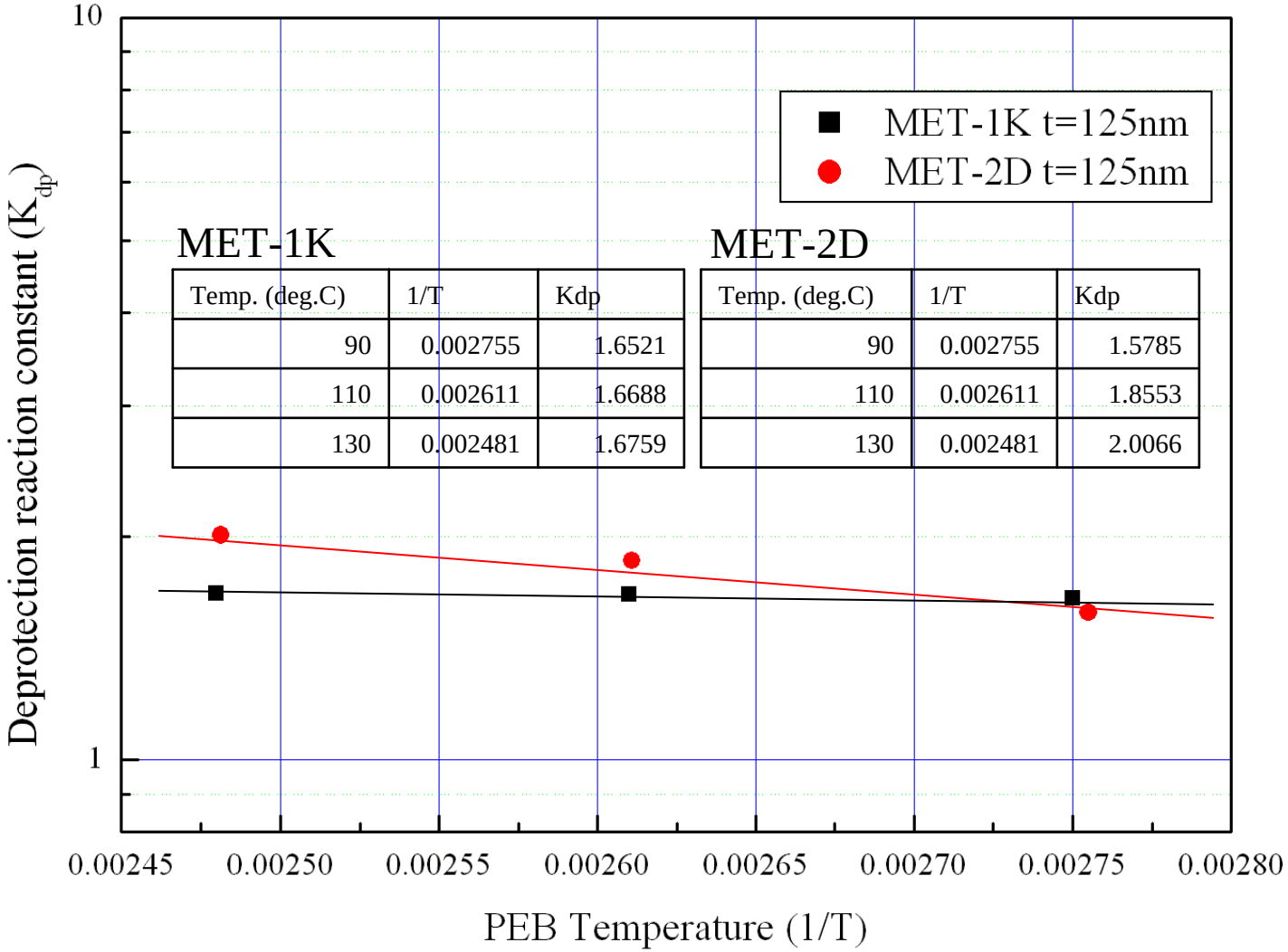
Experiment and result



Deprotection reaction and PEB time at different PEB temperature

MET-2D

Experiment and result



MET-1K

Temp. (deg.C)	1/T	Kdp
90	0.002755	1.6521
110	0.002611	1.6688
130	0.002481	1.6759

MET-2D

Temp. (deg.C)	1/T	Kdp
90	0.002755	1.5785
110	0.002611	1.8553
130	0.002481	2.0066

Arrhenius plot

Experiment and result

MET-1K	Ea(mol/Kcal)	ln(Ar)
K_{amp}	3.8228	5.533
K_{diff}	8.7989	11.499
D	5.0000	30.000

MET-2D	Ea	ln(Ar)
K_{amp}	2.2300	3.550
K_{diff}	1.0000	1.783
D	5.0000	30.000

Conclusion

We are developing the FT-IR equipment for de-protection reaction analysis for EUVL.
This system has IR light devised the equipment which enters at the angle of 45 deg to a wafer.
It turned out that a de-protection reaction can also observe the super-thin film sample of 25nm of film thickness by using this equipment.
EUVL requires ultra thin film of resist. I think that EUV resist research is attained by using this equipment.

Acknowledgement

The Authors would like to thanks Dr. Paul Blackborow, Dr. Peter Craig, Dr. Debbie Gustafson with Energetiq Technology Inc. for Technical discussion.