Ｊａｐａｎ Update on Contamination Control

IEUVI Contamination and Optics Lifetime TWG

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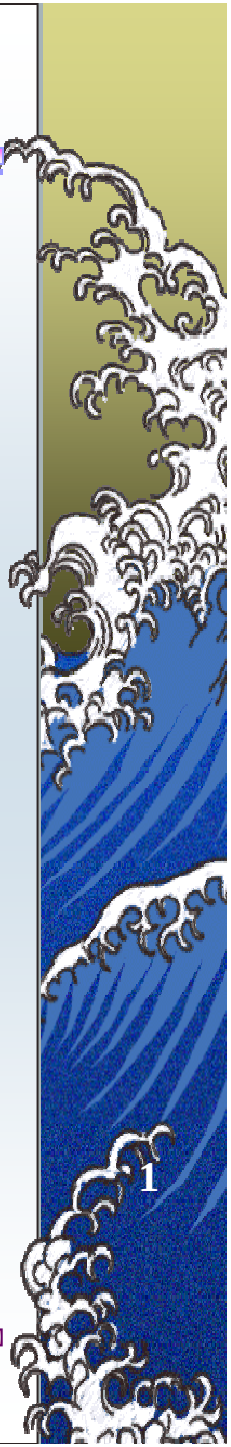
Yasuaki Fukuda
EUVA Tool Laboratory

Recent Progress

1. ASET
2. University of Hyogo
3. EUVA



Outline

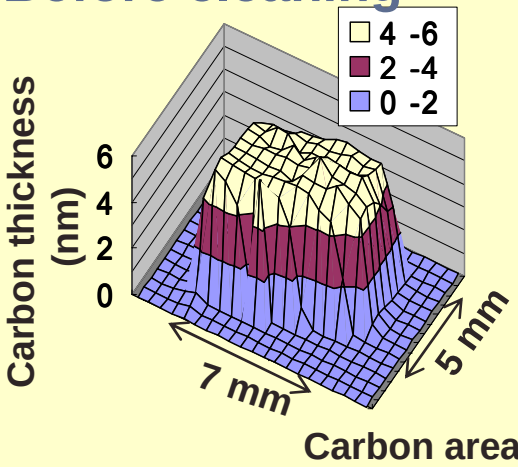
- Contamination control activities are performed at several sites in Japan.
- Removal with atomic hydrogen is investigated at ASET.
  A paper is presented by I.Nishiyama et al. in the Symposium.
- High intensity acceleration test and surface analysis with XANES are studied at LASTI, University of Hyogo.
  Papers are presented by
  - Kakutani et al. (01-CC-11, Poster) and
  - M. Niibe et al. (02-CC-13, Poster) in the Symposium.
- Contamination due to hydrocabons is investigated with various substances.
  A paper is presented by T.Aoki et al. in the Symposium.
- Summary

Active Organization and Topics in Japan

Topic	Organizations		
Suppression of Deposition	EUVA		Univ. of Hyogo/ LASTI
Suppression of Oxidation	EUVA		Univ. of Hyogo/ LASTI
Cleaning/ Reduction	EUVA	ASET	
Outgassing		ASET	Univ. of Hyogo/ LASTI
Mechanism Study	EUVA		Univ. of Hyogo/ LASTI

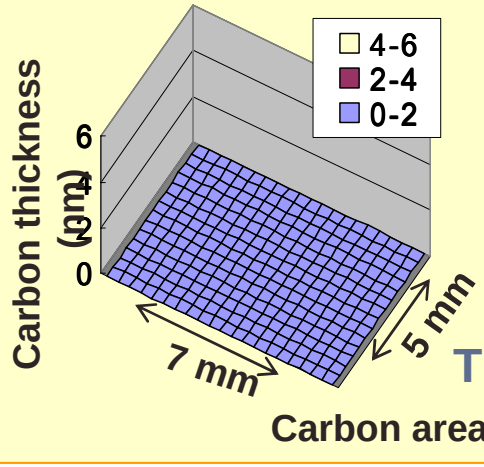
Atomic-H Cleaning of Carbon Contamination

Before cleaning



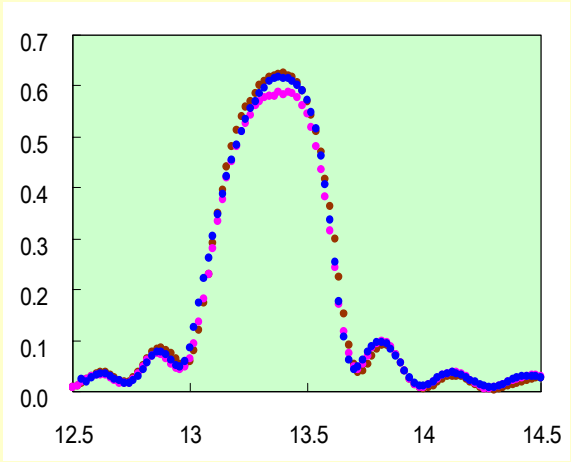
Thickness: 5.6 nm

After cleaning



Thickness: negligible

Reflectivity recovery



As sputtered : 62.4%

C contamination : 58.9%

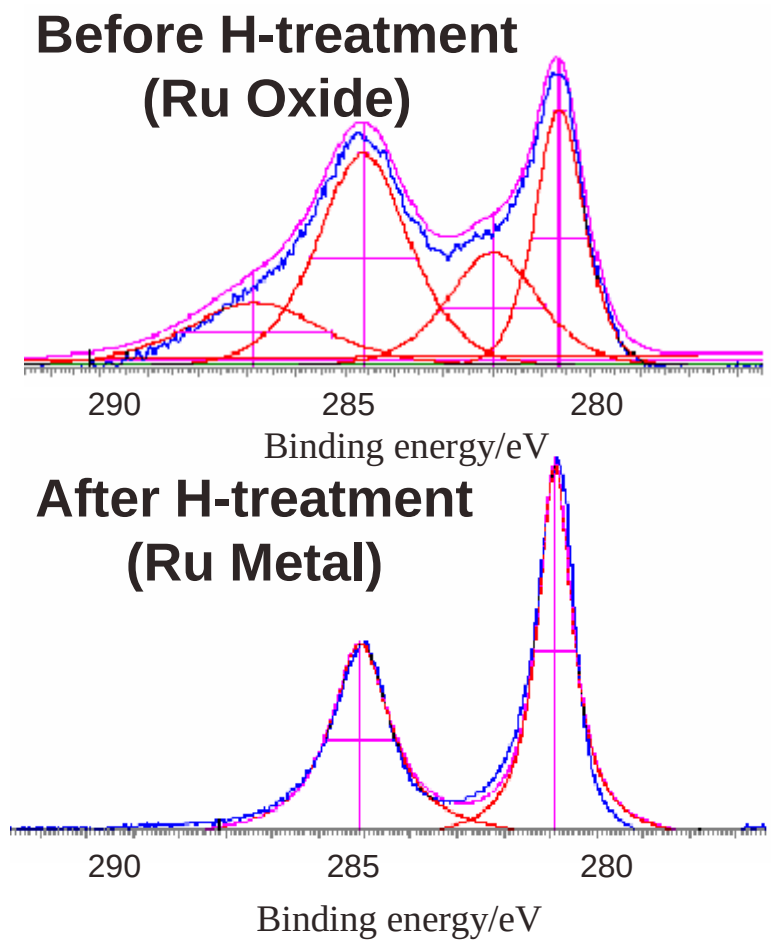
Atomic H cleaning: 61.9%

Oizumi et al. SPIE 2005

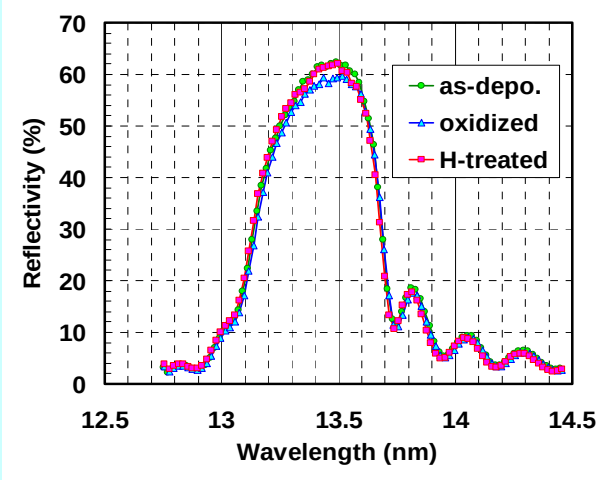
ASET EUV Process Technology

Atomic-H Cleaning of Oxide Layer

Reduction of Ru oxide



Reflectivity recovery



As sputtered : 62.3 %

C contamination : 59.6 %

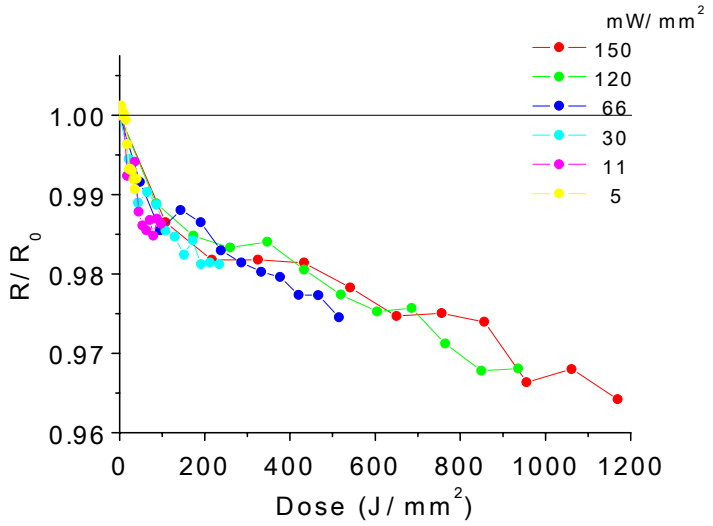
Atomic H cleaning: 62.0 %

Nishiyama et al. EIPBN 2006

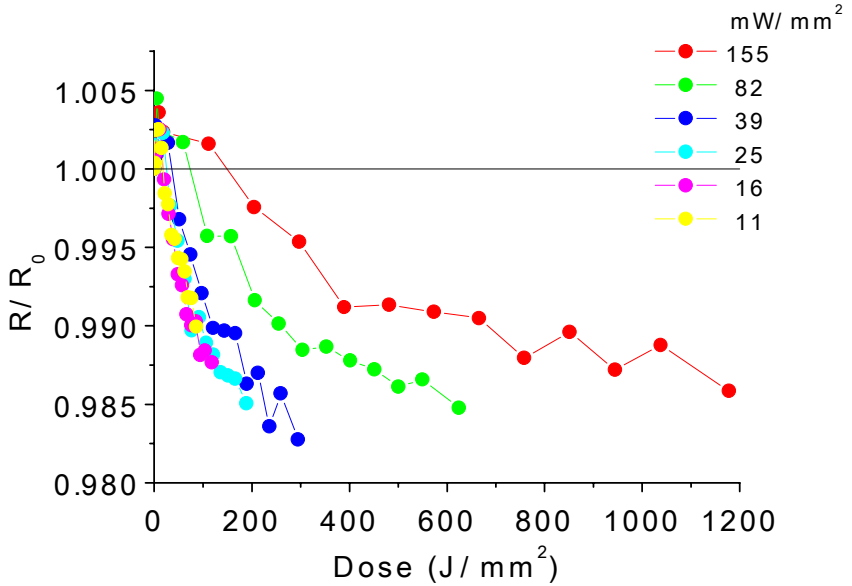
ASET
EUV Process Technology

Acceleration test under different water pressure

Reflectance changes
(H_2O: 1.3E-3 Pa)



Reflectance changes
(H_2O: 1.3E-5 Pa)

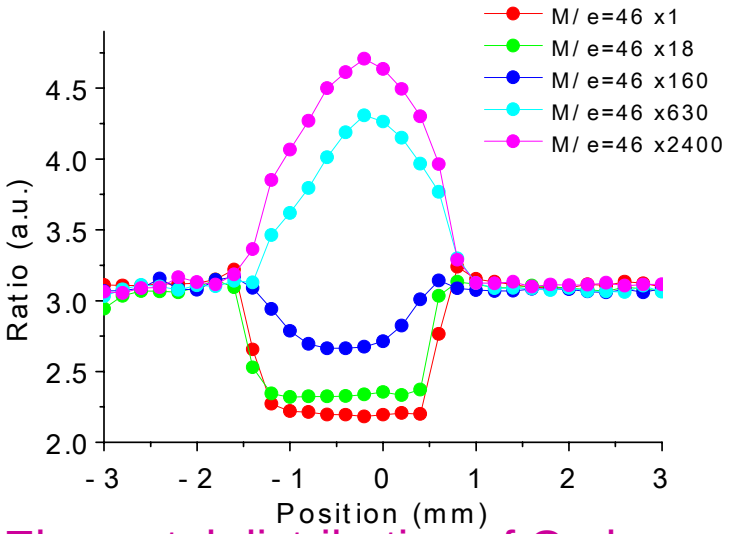


01-CC-11(Poster) Y.Kakutani et al.,"High Acceleration Test for Contamination of Ru Capping Layers for EUVL Projection Optics Mirrors"

Elemental distribution by XANES analysis

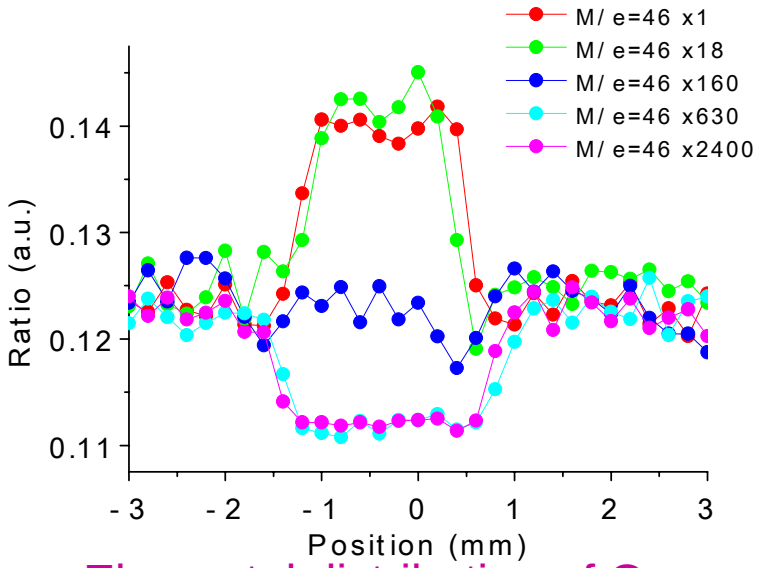
Ru-capped MLM irradiated under EtOH introduced conditions.

I (293 eV) / I (279 eV)



Elemental distribution of Carbon in the irradiated area.

I (541 eV) / I (517 eV)

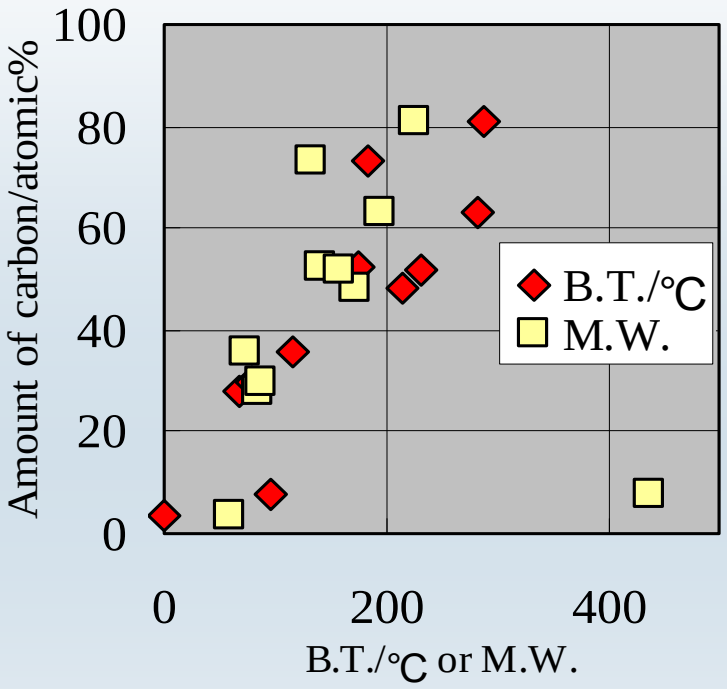


Elemental distribution of Oxygen in the irradiated area.

02-CC-13(Poster) M.Niibe et al.;"In situ XANES Analysis for EUVL Projection Optics Contamination"

Dependence on Organic Gas Species

Organic gas	B.T./℃	M.W.
Buthane	-1	58
Buthanol	117	74
Methyl propionate	79	88
Hexane	69	86
Perfluoro octane	97	438
Decane	174	142
Decanol	231	158
Methyl nonanoate	214	172
Diethyl benzene	183	134
Dimethyl phtalate	283,7	194
Hexadecane	287	226



- ✓ XPS can reveal deposited carbon while ΔR is negligible.
- ✓ Organic gases with higher boiling temperature or heavier molecular weight show larger carbon deposition rates.

Oct.18 Contamination: T.Aoki et al.,"Carbon deposition on multilayer mirrors by extreme ultraviolet ray irradiation"

Summary

- ASET Activity:
  Cleaning with atomic hydrogen is investigated and found it effective to remove carbon deposition on the multilayer mirror without reflectivity degradation.
- University of Hyogo & EUVA Activity:
  Accelerated lifetime testing is available if proper environmental conditions are considered.
  Surface analysis with XANES is useful for evaluation of deposition.
- EUVA Activity:
  Effects of hydrocarbons to carbon deposition are studied.
  Higher boiling point or larger molecular weight residual gases works as deposition sources.

Thank you.