EUVA Canon

Contamination & Optical lifetime Update

IEUVI Optics Contamination and Lifetime TWG

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Recent Activity

1. Contamination and cleaning study
2. From the presentations

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Presentations related to Cleaning and Resist-Outgassing Picked up from CC section and partially RE.

	Japan				Korea
	EUVA	Selete	University of Hyogo	Companies	Hanyang University
Projection Optics	CC-P10 H.Takase	CC-02 I.Nishiyama	CC-P09 K.Koida		
Source Mirrors	CC-P02 T.Shirai				
Masks		CC-02 I.Nishiyama		CC-P15 K.Sakai	CC-P14 T.Kim
Resist Outgassing		Re-P08 J.J.Santillan			Re-P09 S.Lee

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Optics contamination:

- I.Nishiyama(Selete), “Atomic hydrogen cleaning for EUV optics contamination”,
  Carbon contamination is thouroughly removed and showed no damage to reflectivity; and this method is applicable to Ta_2O_5 absorber material for mask.
- T.Shirai(EUVA), “Debris mitigation and mirror cleaning for Sn-fueled EUV source”,
  More than 60 times halogen cleaning keeps high reflectivity.
- K.Koida(University of Hyogo), “Reduction of surface oxide layer of projection optics mirrors by EUV irradiation in presence of ethanol”,
- H.Takase(EUVA), “Characteristics of additional carbon on the surface of carbon capping layer”.
  Carbon deposition rate is proportional to square root of EUV intensity.

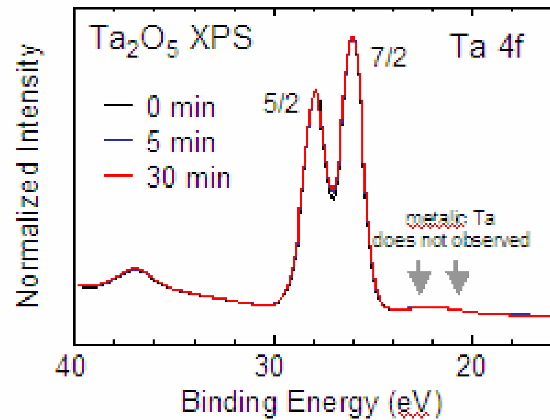
Mask cleaning:

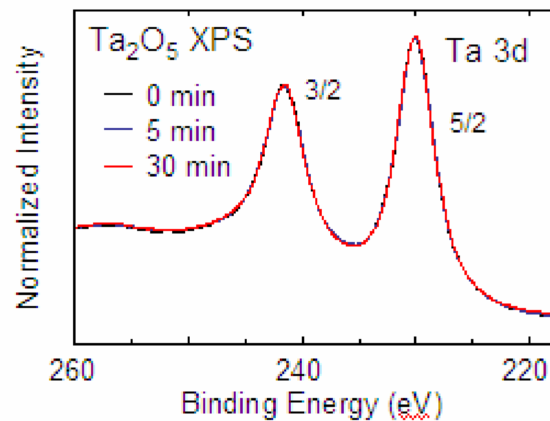
- T.Kim(Hanyang University), “Surface properties of EUVL mask layer after high energy laser shock cleaning”, alumina particles are safely removed by laser shockwave.
- K.Sakai(Toppan Printing), “A study of cleaning characteristics for EUV mask blank”, Organic compound contamination can be removed by UV/O3 cleaning and showed no damage.

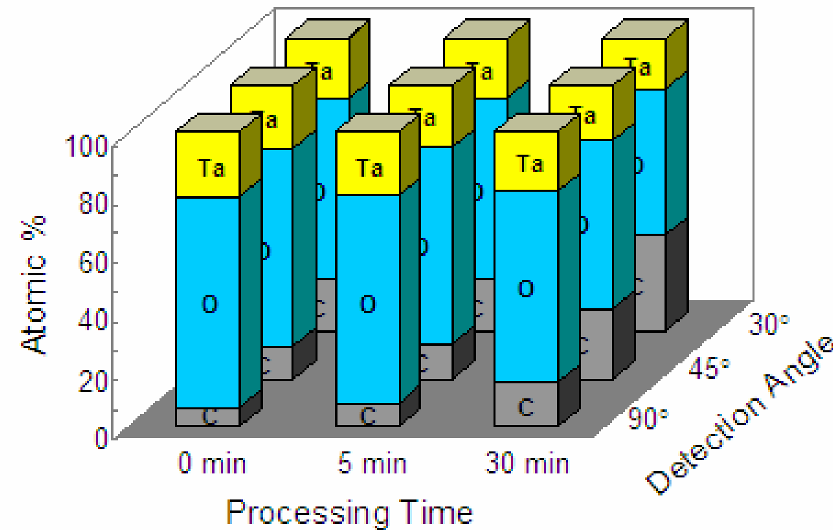
Resist outgassing:

Not cited here.

Impact of atomic hydrogen on Ta_2O_5



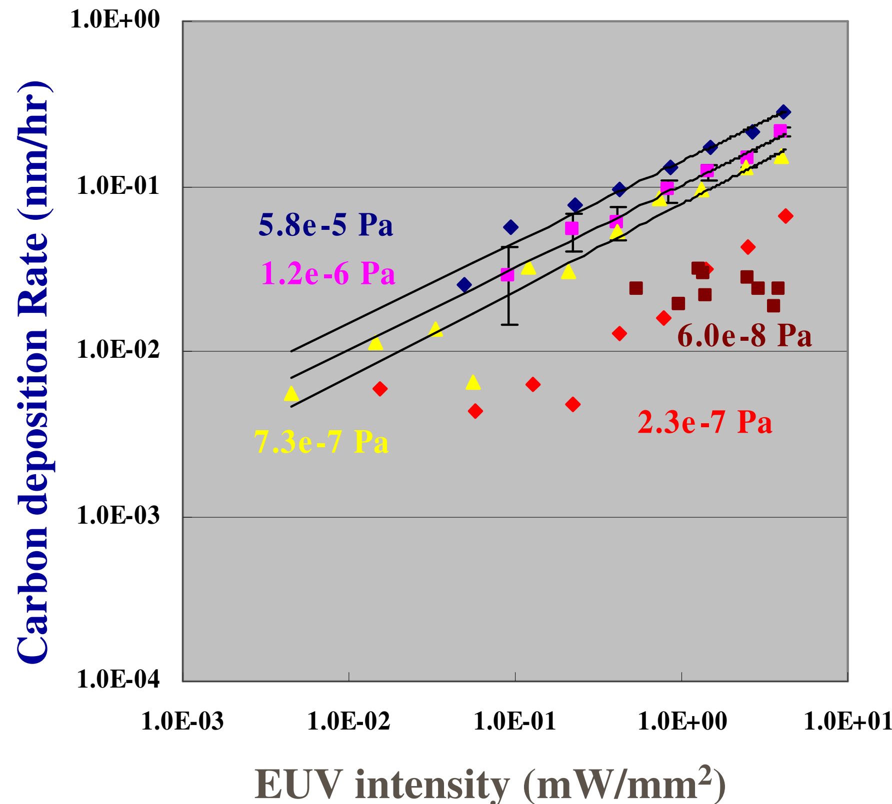




Ta_2O_5 is stable to atomic hydrogen treatment

Oct. 31, 2007 EUVL Symposium 2007, Sapporo 17

CC-P10: Characteristics of additional carbon on the surface of the carbon capping layer (Takase, *et al.* EUVA)



Sample:
[Si(4.2nm)/ Mo(2.8nm)]^{50}

Contamination source:
decane $C_{10}H_{22}$

The carbon deposition rate is **proportional to the square root of EUV intensity** at 4 mW/mm^2 or less with decane pressure more than 7.3 x 10^{-7} Pa.

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Mirror lifetime test of halogen cleaning

CC-P02: Debris mitigation and mirror cleaning for Sn-fueled EUV source(T.Shirai, *et al.*, EUVA)

Normalized reflectivity: 105, 100, 95, 90, 85, 80

Cleaning cycle (time): 0, 10, 20, 30, 40, 50, 60, 70

-Calculation Mirror Lifetime-

$R_{normalized}$ = 90%
@ 454 time of cleaning

Sn deposition rate =
3.2×10^{-8} nm/pulse

Sn thickness (R = 90%) = 0.4 nm

$0.4/3.2\times10^{-8}$

12.5 Mpulses

Mirror Lifetime = $454 \times 12.5\times10^{6}$ =

5.7 Bpulses

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Reduction of Ru capping layer in ethanol environment

CC-P09: Reduction of surface oxide layer of projection optics mirrors by EUV irradiation in presence of ethanol (K.Koida, *et al.*, Univ. of Hyogo)

P_{H2O}=1.3E-4 (Pa) ← → P_{EtOH}=3.8E-5 (Pa)

Relative reflectivity

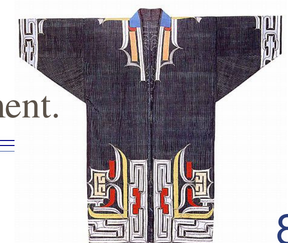
1.010
1.005
1.000
0.995
0.990
0.985

0 500 1000 1500

Dose (J/mm^2)

mW/mm^2
274

Introduction of ethanol



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For details, please see the presentations below:

CC-02: Atomic hydrogen cleaning for EUV optics contamination,

CC-P02: Debris mitigation and mirror cleaning for Sn-fueled EUV source,

CC-P09: Reduction of surface oxide layer of projection optics mirrors by EUV irradiation in presence of ethanol,

CC-P10: Characteristics of additional carbon on the surface of carbon capping layer,

CC-P14: Surface properties of EUVL mask layer after high energy laser shock cleaning,

CC-P15: A study of cleaning characteristics for EUV mask blank,

RE-P08: EUV resist outgassing studies in Selete,

RE-P09: Outgassing study of resist for extreme ultraviolet lithography at PAL.

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Thank you