

The Resist Outgassing in the EUV Exposure

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Outline

1. Introduction
2. Experimental Setup
3. Result and Discussion
4. Conclusion

The importance of the investigation of the photo-induced outgassing from the resist

EUVL required the vacuum environment for the exposing the resist. The contamination in the vacuum environment decreases the reflectivity of the reflective mask and that of the imaging optics. The photo-induced outgassing from the resist becomes the contamination in the vacuum environment. Therefore, it is very important that the outgassing characteristics from the resist during exposure have to be investigated.

Resist specification for EUVL

- (1) Resolution : $\leq 0.1 \mu\text{m}$
- (2) Sensitivity : $\leq 10 \text{ mJ/cm}^2$
- (3) Thickness : $\leq 0.15 \mu\text{m}$
- (4) Low edge roughness
- (5) **Low Outgassing**
- (6) Etch resistance : $\geq 1 \sim 1.5$
- (7) Wall slope : ≥ 85 degrees

Resists utilized for the outgassing experiment

1. Chemically Amplified Resists

1) Positive-tone resist

UV-5 (Shipley), EUV001(TOK)

2) Negative-tone resist

SAL601 (Shipley), EUV006N (TOK)

2. Non Chemically Amplified resist

1) DQN resist

OEBR2000 (Shipley)

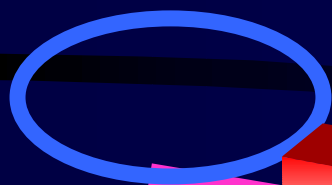
2) ZEP520 (Nippon Zeon)

Resist processing condition for outgassing experiment

| Resist sample | Resist thickness | Prebake condition |
|---------------|------------------|-------------------|
| EUV001 | 100 nm | 130°C, 90 sec |
| UV-5 | 110 nm | 140°C, 60 sec |
| EUV006N | 100 nm | 90°C, 90 sec |
| SAL601 | 100 nm | 90°C, 60 sec |
| OEBR2000 | 130 nm | 90°C, 90 sec |
| ZEP520 | 100 nm | 180°C, 180 sec |

Beamline setup for resist outgassing experiment

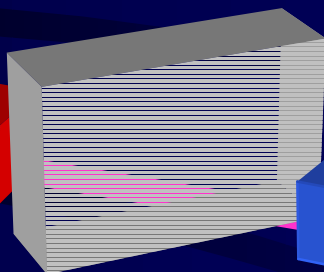
New SUBARU
Storage Ring



M1 M2

Collimating
Optics

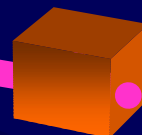
Shield



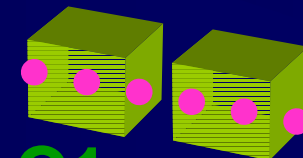
4WS
&
Filter



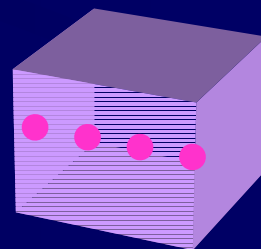
Resist
Test
Chamber



Exposure
Chamber



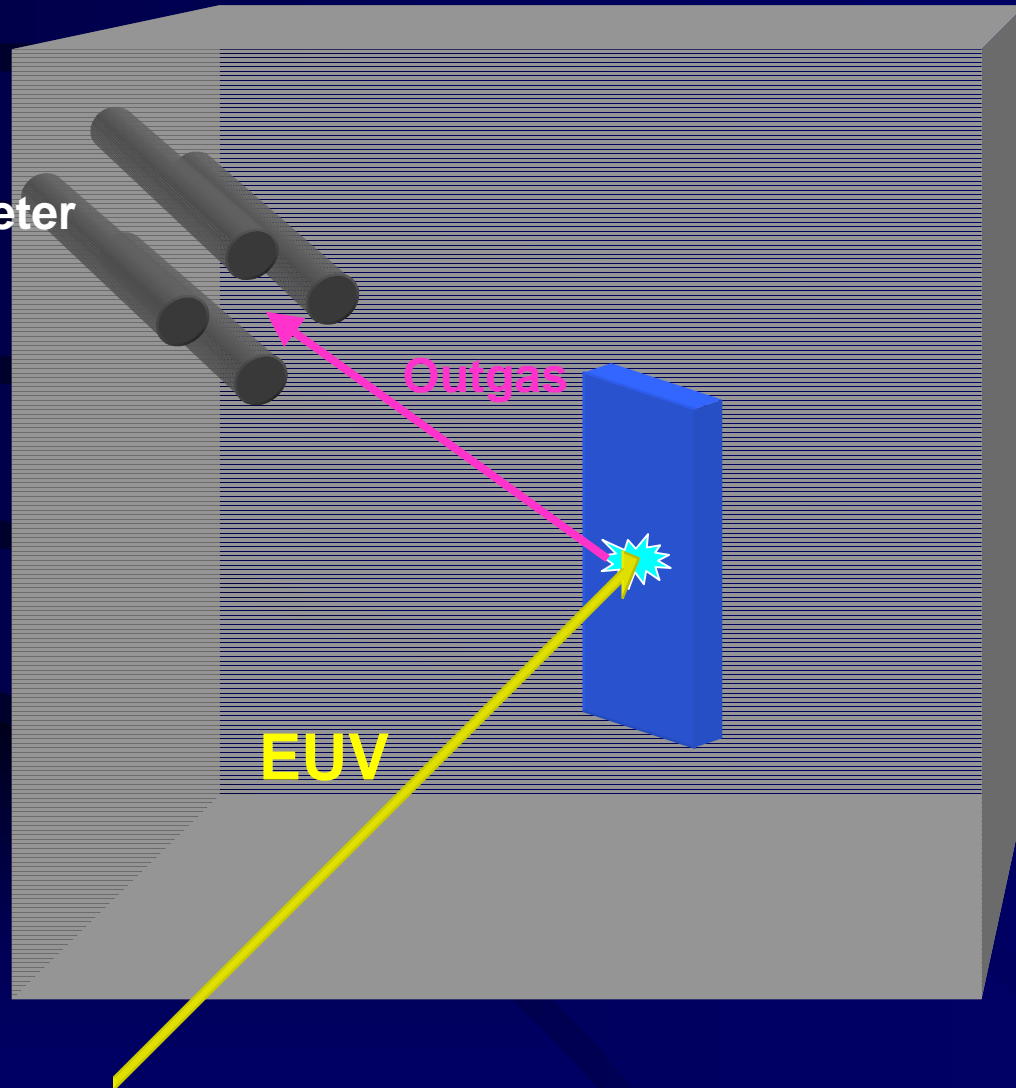
C1 C2
Illumination
Optics



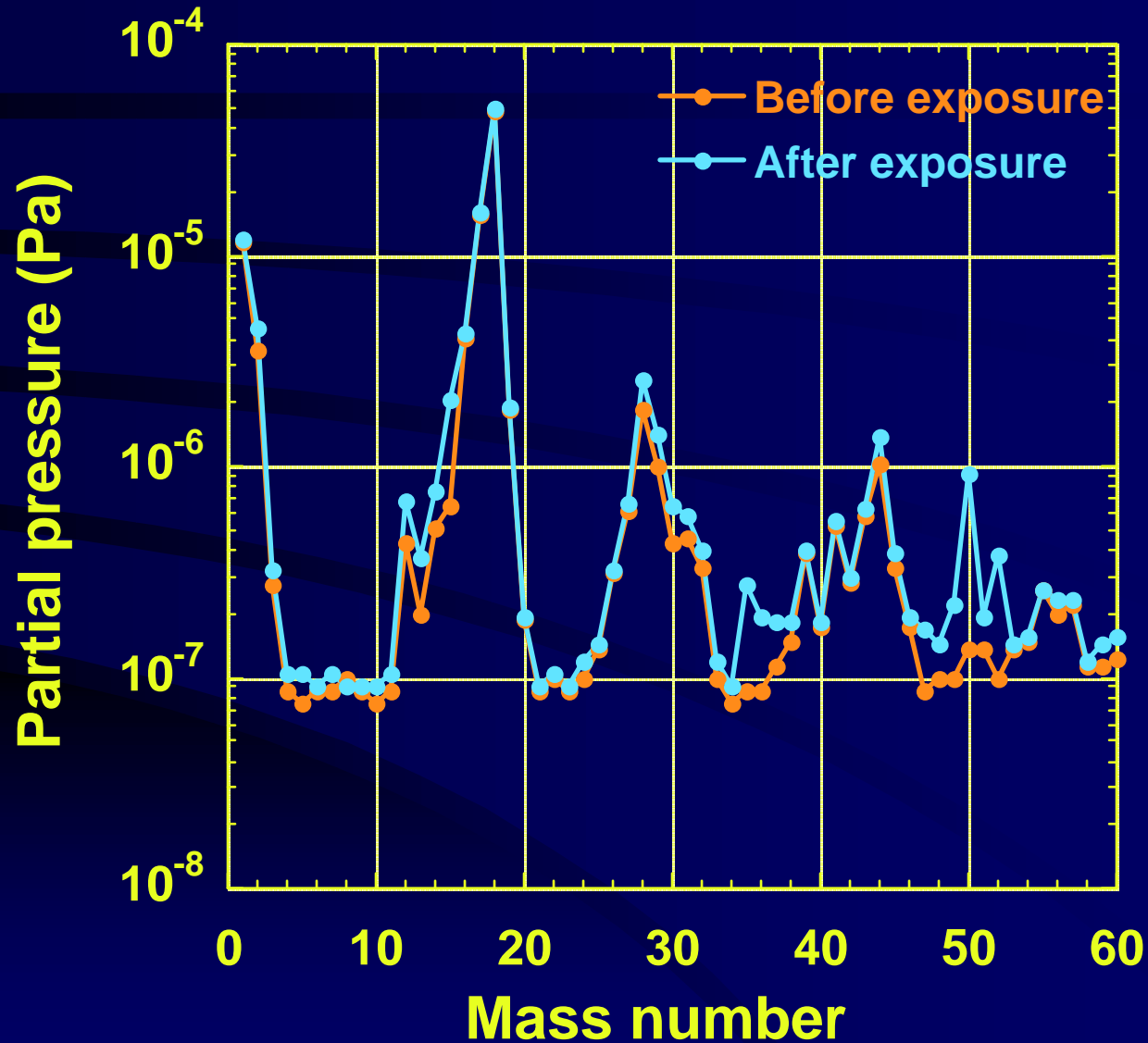
Experimental setup for the outgassing experiment

Resist Test chamber

Quadrupole
mass spectrometer

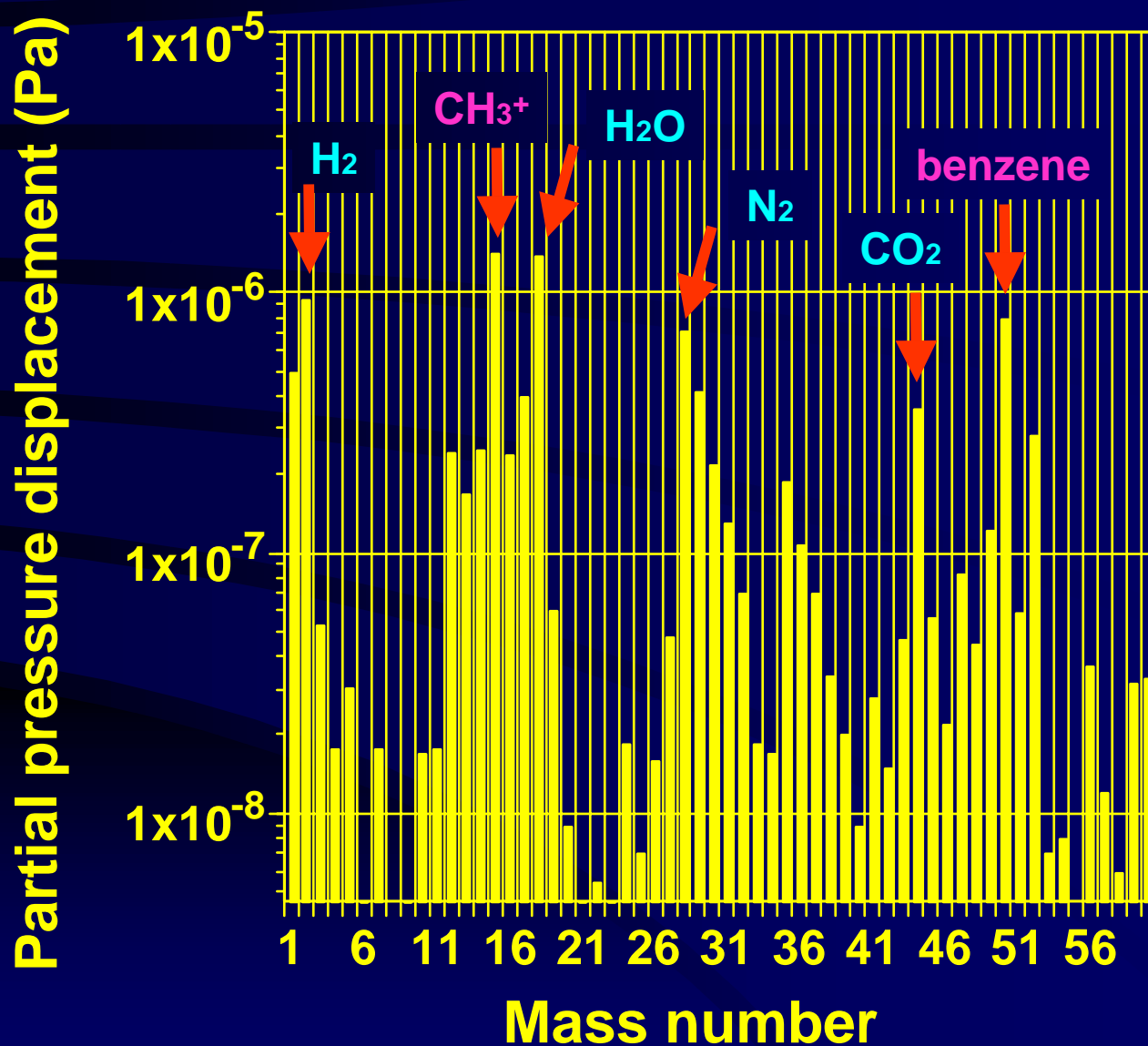


Partial pressure of before and after exposure of ZEP520

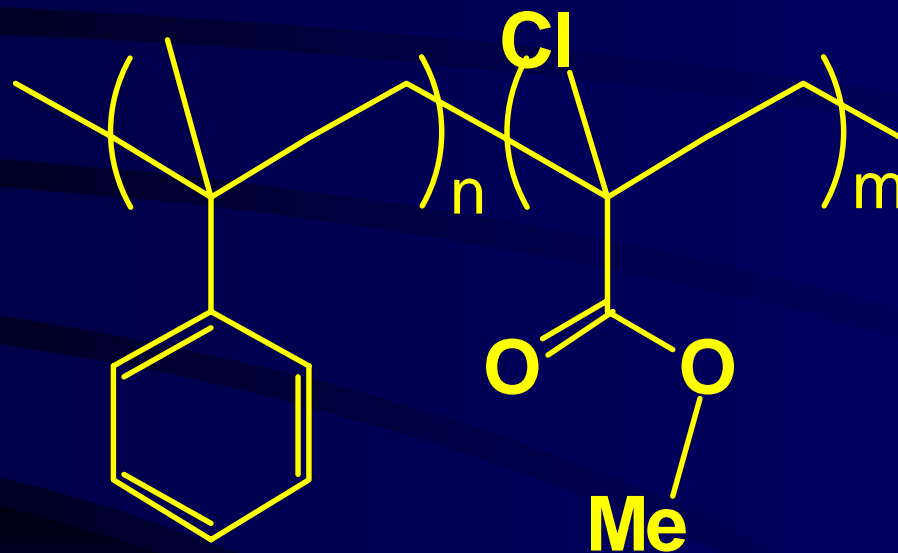


Partial pressure displacement of ZEP520 between after and before exposure

Total Pressure : 1×10^{-4} Pa

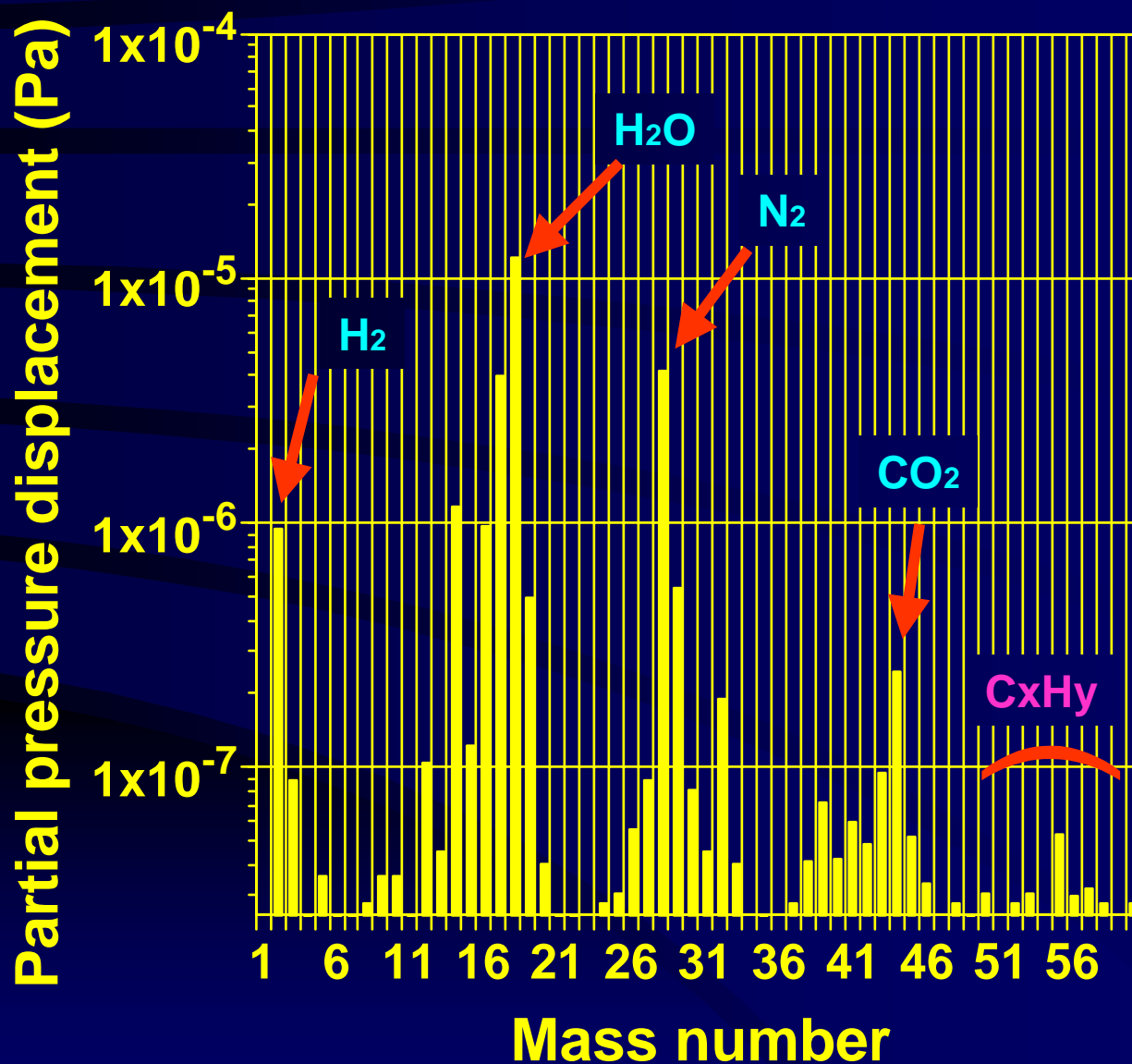


Chemical structure of ZEP520

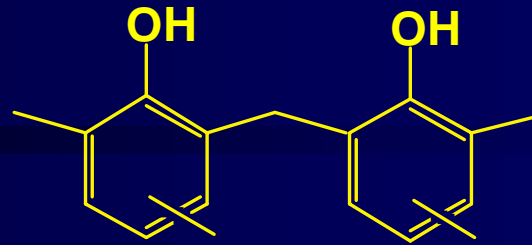


Partial pressure displacement of OEBR2000 between after and before exposure

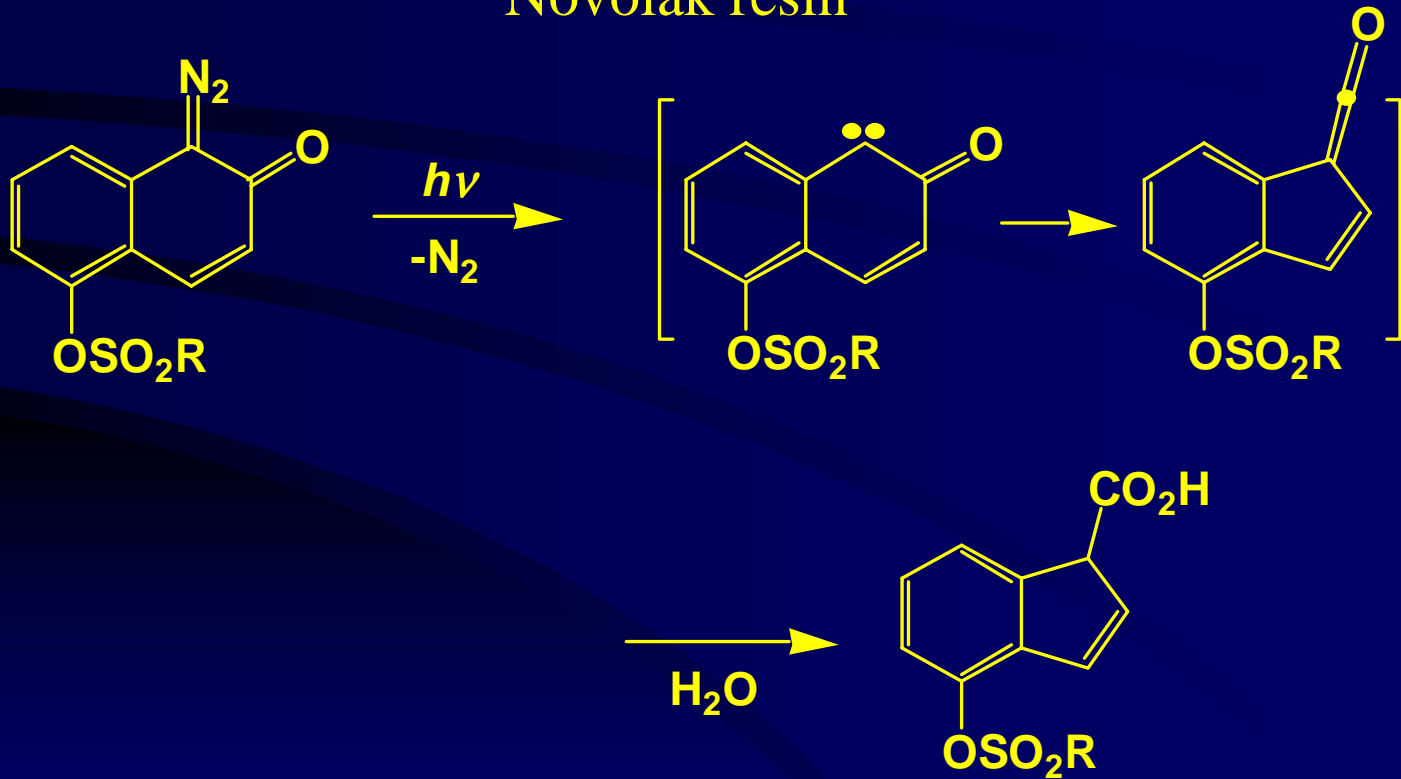
Total Pressure : 1×10^{-4} Pa



Main Reaction of OEBR2000

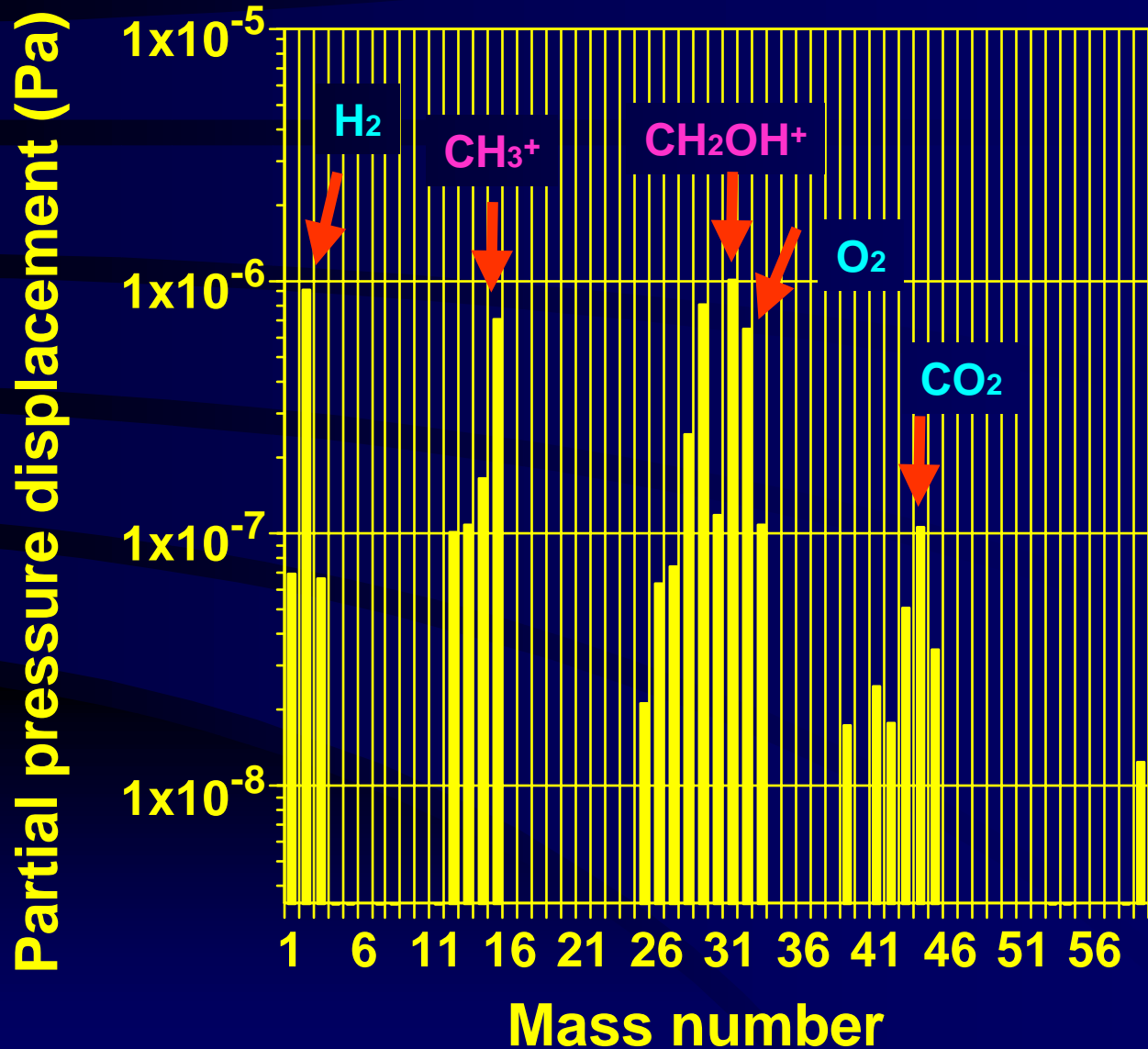


Novolak resin

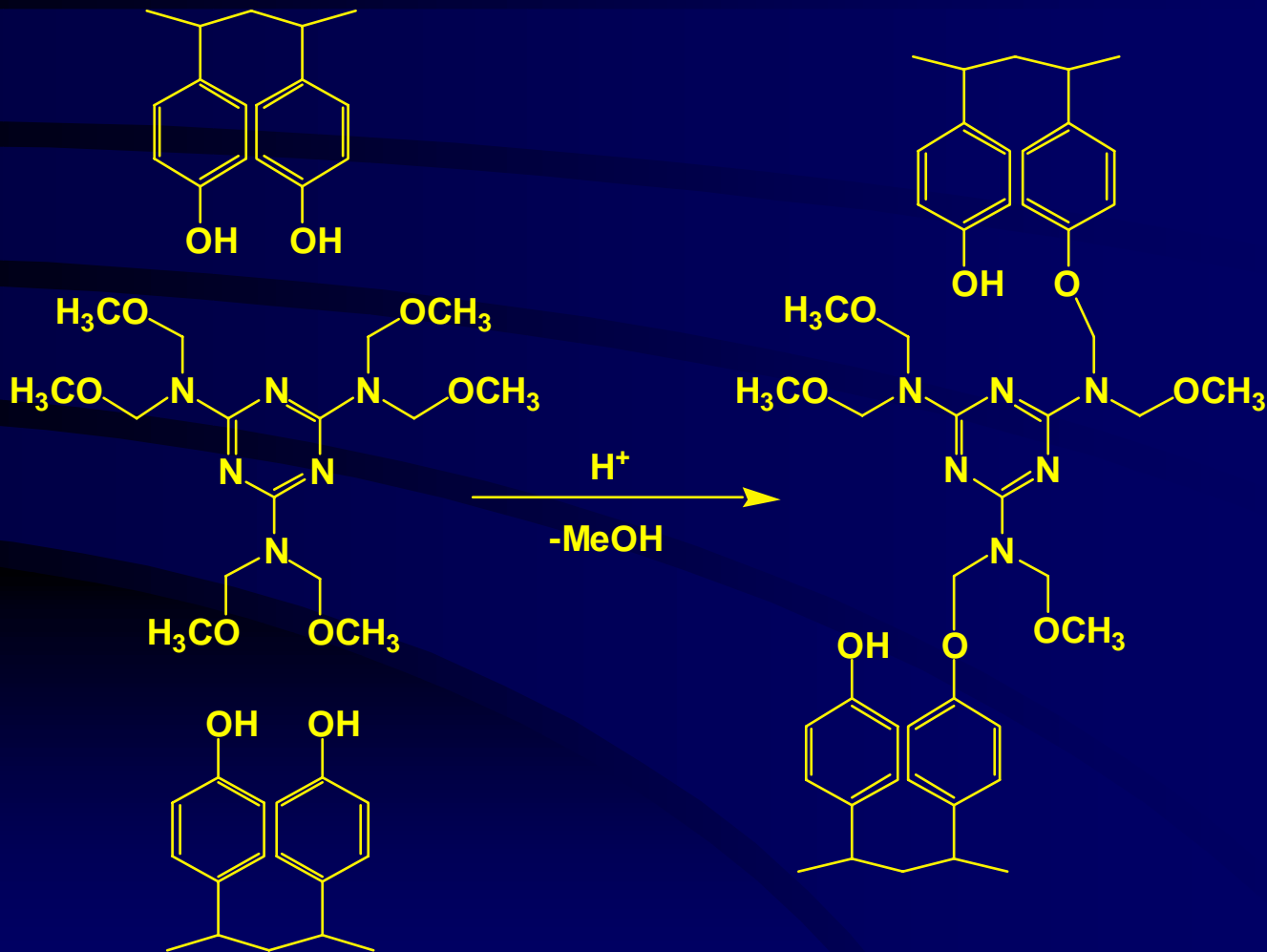


Displacement of the partial pressure of EUV006N

Total Pressure : 1×10^{-4} Pa

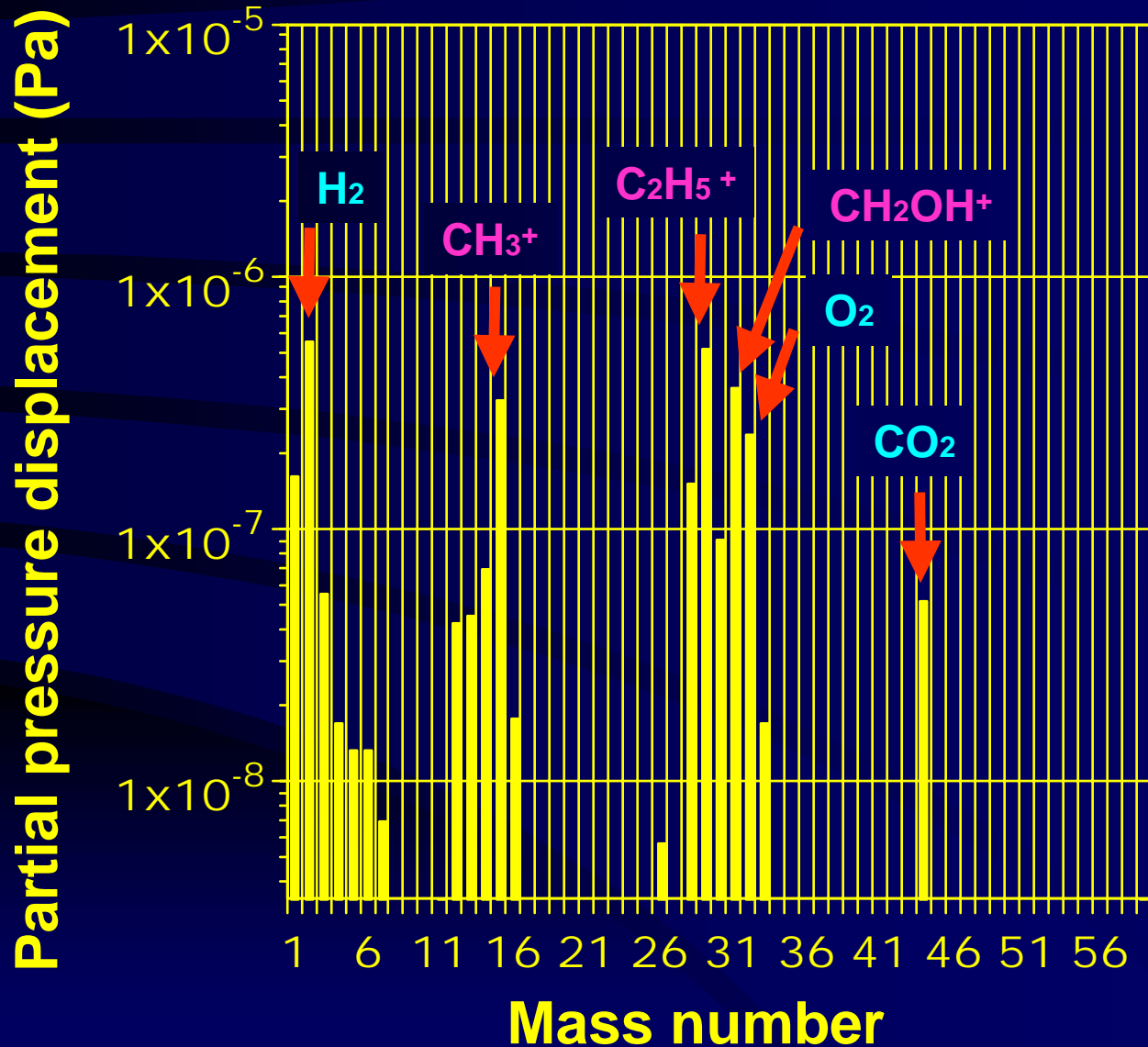


Main Reaction of EUV006N



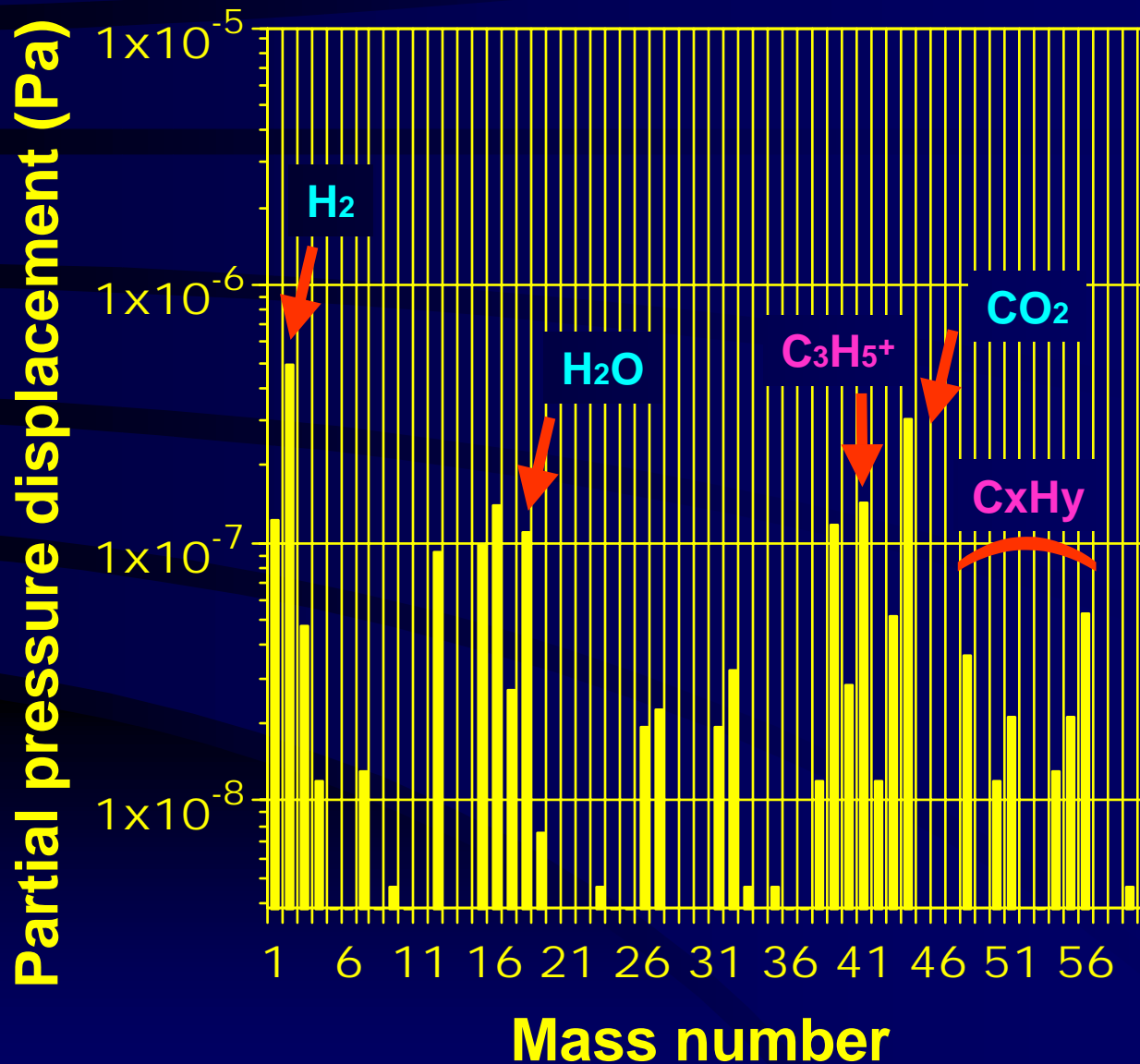
Displacement of the partial pressure of SAL601

Total Pressure : 6.5×10^{-6} Pa

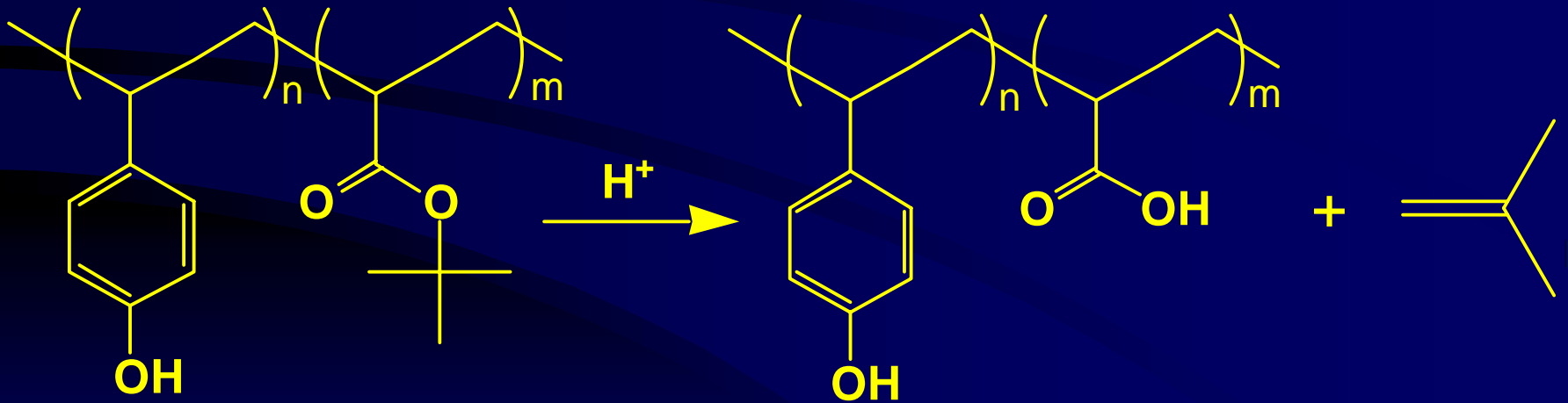


Displacement of the partial pressure of EUV001

Total Pressure : 1.3×10^{-5} Pa

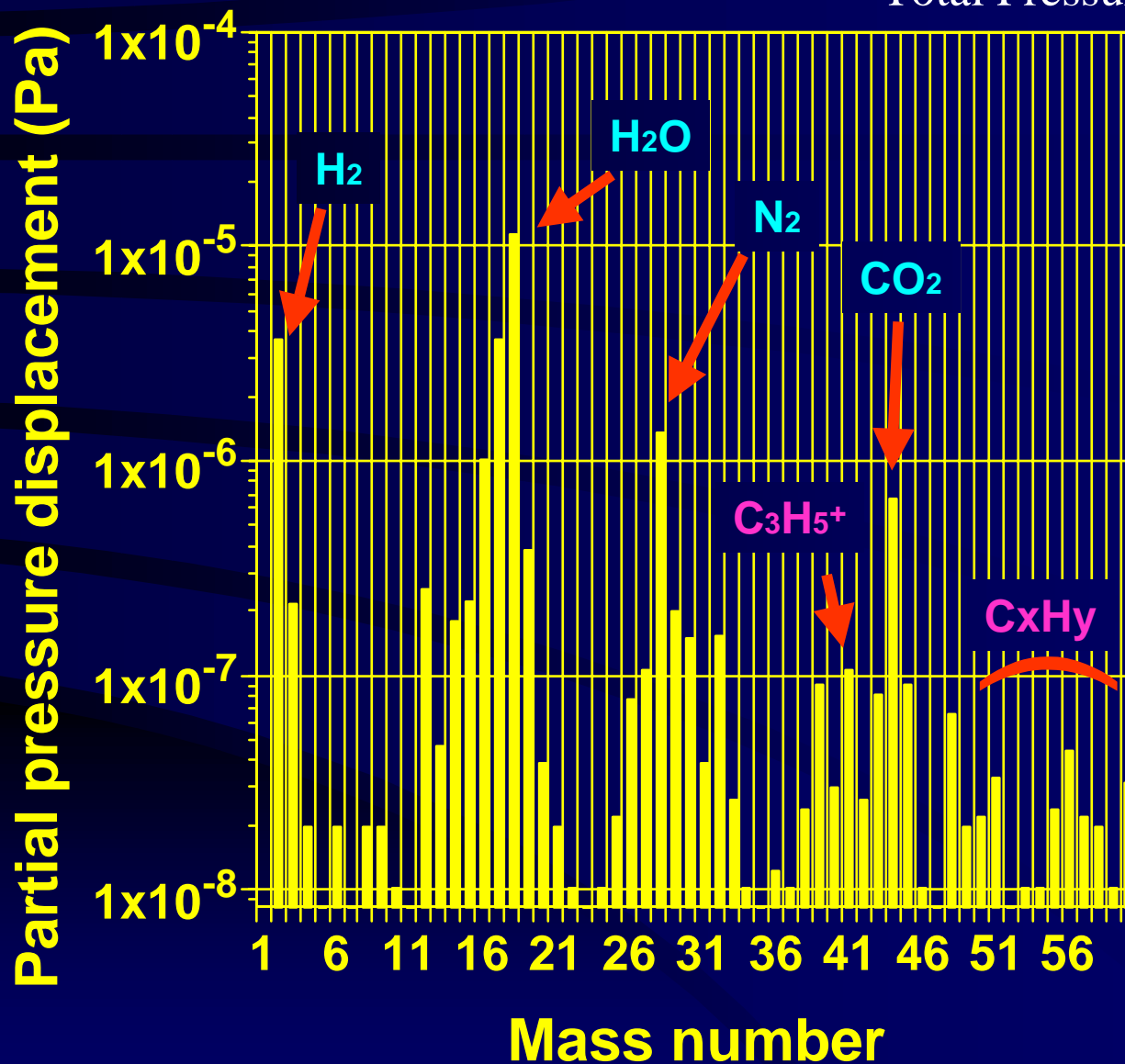


Main Reaction of UV-5 and EUV001



Partial pressure displacement of UV-5 between after and before exposure

Total Pressure : 1×10^{-4} Pa



Conclusion

High outgassing (Partial pressure of CxHy : order of 10^{-6} Pa, @ 1.0^{-4} Pa)

1) ZEP520 (Non CA resist, positive-tone)

High outgassing due to the main chain decomposition.

2) SAL601, EUV006N (CA resist, negative-tone)

Mainly outgassing due to CH₃OH, and from the crosslinker.

3) EUV001, UV-5 (CA resist, positive-tone)

CxHy outgassing is ten times smaller than that from ZEP520.

4) OEBR2000 (Non CA resist, positive-tone)

Mainly outgassing due to N₂.

Low outgassing (Partial pressure of CxHy : order of 10^{-8} Pa, @ 1.0^{-4} Pa)

Displacement of the partial pressure of EUV010

Total Pressure : 1×10^{-4} Pa

