Outgassing Measurement in the University of Hyogo (NewSUBARU)

Takeo Watanabe, Hiroo Kinoshita

¹University of Hyogo

E-mail address: takeo@lasti.u-hyogo.ac.jp
Outline

1. The detail of resist evaluation system
2. Outgassing measurement result
Setup of novel resist evaluation system

1) Measurements of sensitivity
2) Outgas characteristics
3) Chemical reaction analysis

Simulating six-mirror optics

Practical exposure spectrum

- Mo/Si MLs
- Concave Mirror
- PC controlled fast speed shutter ($\Delta t=11$ ms)
- Mo/Si MLs Two Plane Mirrors
- Sample
- Distance 30 mm
- High-sensitive ion counting type Q-mass spectrometer
  Model HAL/3F/PIC 501 RC, Hiden Analytical, Ltd.
- SR
Reflectivities spectra of Mo/Si MLs

- Concave Mirror
- Plane Mirror
- Seven-Times Reflection
Setup of novel resist evaluation system

Loadlock chamber

Sample

Shutter chamber

Gate valve

Sample chamber

Gate valve

Sample insertion rod

Loadlock chamber

Gate valve

Sample
Setup of resist evaluation system

Simulating a six-mirror optics

Exposure chamber

Loadlock chamber

SR
Sample exposure

Loadlock chamber
Pumping time: 1 hour to $10^{-5}$ Pa

Sample chamber: $2 \times 10^{-6}$ Pa
Sample size: 85 mm $\times$ 18 mm
Exposure area: 4 mm $\times$ 4 mm / shot
Total shots: 12 shots/sample
Experimental Conditions

• Substrate : Si Wafer
• Film Thickness : 125 nm
• PAB : 140°C 60 s
• Exposure : $\lambda = 13.5\text{nm}$
  $200\text{mA} \ (0.05 \text{mW/cm}^2)$
Partial pressure after exposure

Round Robin (after exposure)
Partial pressure displacement after and before exposures

Mass Number

Partial Pressure Displacement

1.0E-10
1.0E-09
1.0E-08
1.0E-07
1.0E-06

1  10  19  28  37  46  55  64  73  82  91  100  109  118  127  136  145  154  163  172  181  190  199
Sensitivity Curve of Round Robin Sample

$E_0=4.99 \text{ mJ/cm}^2$
<p>| | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Total pressure (Pa)</td>
<td></td>
<td>$4.02 \times 10^{-7}$</td>
</tr>
<tr>
<td>molecules/s/cm²</td>
<td></td>
<td>$2.39 \times 10^{14}$</td>
</tr>
<tr>
<td>Sensitivity</td>
<td></td>
<td>$4.99$ mJ/cm²</td>
</tr>
<tr>
<td>molecules/cm²</td>
<td></td>
<td>$2.39 \times 10^{16}$</td>
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</tbody>
</table>

$$M\left(\text{molecules/s/cm}^2\right) = \frac{P\left(\text{Pa}\right) \times 300\left(l/s\right) \times 6.02 \times 10^{23} \left(\text{molecules}\right)}{22.4\left(l\right) \times 760\left(torr\right) \times 133.32\left(\text{Pa/torr}\right) \times 0.4\left(cm\right) \times 0.4\left(cm\right)}$$
Partial pressure displacement after and before exposure (Pa)

<table>
<thead>
<tr>
<th></th>
<th>H, H2</th>
<th>CO</th>
<th>CO2</th>
<th>Isobutene</th>
<th>Benzene</th>
<th>t-butylbenzene</th>
<th>≥45</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>before</td>
<td>1.83E-05</td>
<td>4.25E-06</td>
<td>5.95E-06</td>
<td>2.66E-07</td>
<td>5.96E-08</td>
<td>2.68E-07</td>
<td>3.32E-08</td>
<td>4.02E-05</td>
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<tr>
<td>after</td>
<td>4.55E-01</td>
<td>1.06E-01</td>
<td>1.48E-01</td>
<td>6.62E-03</td>
<td>1.48E-03</td>
<td>6.68E-03</td>
<td>8.26E-04</td>
<td>Ratio</td>
</tr>
</tbody>
</table>