**Structural analysis of photoresist at boundary area in resist pattern**

It is very important for further miniaturization of semiconductor devices to investigate correlation between chemical structure of resist and Line Width Roughness (LWR). In this study, a novel sampling technique and Pyrolysis-GC/MS combined with micro-GPC enable us to analyze chemical structures of resist pattern in detail.

**Approach for LWR analysis**

*Optical intensity in L/S pattern (simulation)*

- The optical intensity was dramatically changed at **boundary area**.

The resist pattern at boundary area was analyzed.

**Samples**

<table>
<thead>
<tr>
<th>Polymer</th>
<th>PAG</th>
<th>Illumination</th>
<th>Lithographic performance (70nmL/40nmS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Annular: LWR 7.8 min. Cost: 15.5 mJ/cm²</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dipole: LWR 5.5 min. Cost: 15.5 mJ/cm²</td>
</tr>
</tbody>
</table>

**Novel method for the analysis of resist pattern**

*Solution 1: Establishment of sampling method*

- The solvent in which resist-components moderately dissolve is selected.
- The boundary area (surface) of resist pattern is collected by soaking in organic solvent for a short time.

*Solution 2: Application of micro-GPC*

- GPC Fractions are dropped on sample plate or cup directly. Accordingly it is easy to be applied to IR, Pyrolysis-GC/MS (Py-GC/MS) and MALDI-MS measurements.
- Injection volume: tens of micrograms.

**Results of analysis for resist pattern**

*Comparison between core and surface (boundary area)*

- From GPC measurement:
  - More polymer were dissolved.
  - The boundary area was wide.
- From Py-GC/MS measurement:
  - Deprotection reaction more proceeded.
  - This area was illuminated halfway.

- The optical contrast was low.

These results were consistent with simulation result.

**Conclusion**

A novel method for the direct analysis of the boundary area in resist pattern was developed.

The difference of the optical contrast at boundary area was related to the actual chemical structures.

*Joint study with JSR Corp.*