Technical Report

ZEONREX Electronic Chemicals

ZEP520A
High Resolution Positive Electron Beam Resist

ZEP520A

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http://www.zeon.co.jp/
Any process conditions and data are examples.
Those will not guarantee the same data in customers’ process.
1. Characteristics

ZEP520A is high performance positive EB resists which show high resolution, high sensitivity and dry etch resistance.

They are suitable for various EB processes.

(1) Resolution
Shows high resolution and rectangle pattern profile.

(2) Resistance to dry etching
Shows high dry etch resistance and they are almost equivalent to that of positive photoresists generally used.

(3) Sensitivity
Shows high sensitivity.

2. Properties

<table>
<thead>
<tr>
<th>Item</th>
<th>Mw</th>
<th>Viscosity (mPa · s)</th>
<th>Solvent</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZEP520A</td>
<td>57,000</td>
<td>11</td>
<td>Anisol</td>
<td>1QT bottle or 100ml bottle</td>
</tr>
<tr>
<td>ZEP520A-7</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Thinner

<table>
<thead>
<tr>
<th>Item</th>
<th>Composition</th>
<th>Remarks</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZEP-A</td>
<td>Anisol</td>
<td>ZEP520A</td>
<td>1QT bottle</td>
</tr>
</tbody>
</table>

4. Developer

<table>
<thead>
<tr>
<th>Item</th>
<th>Composition</th>
<th>Remarks</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZEP-RD</td>
<td>Xylene(o-,m-,p- mixed)</td>
<td>standard</td>
<td>1GL bottle</td>
</tr>
<tr>
<td>ZED-N50</td>
<td>n-Amyl acetate</td>
<td>high resolution</td>
<td></td>
</tr>
<tr>
<td>ZEP-SD</td>
<td>2-Butanone 40% Methyl isobutyl ketone 60%</td>
<td>high sensitivity</td>
<td></td>
</tr>
</tbody>
</table>

※ ZED—N50 is recommended!

5. Rinse

<table>
<thead>
<tr>
<th>Item</th>
<th>Composition</th>
<th>Remarks</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZMD-B</td>
<td>Methyl isobutyl ketone 89%</td>
<td>Isopropyl alcohol 11%</td>
<td>1GL bottle</td>
</tr>
</tbody>
</table>

6. Remover

<table>
<thead>
<tr>
<th>Item</th>
<th>Composition</th>
<th>Remarks</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZDMAC</td>
<td>Dimethylacetamide</td>
<td></td>
<td>1GL bottle</td>
</tr>
</tbody>
</table>
7. Spin Curve

**ZEP 520A Spin curve (1)**

![Graph of ZEP 520A Spin curve (1)](image)

**ZEP 520A Spin curve (2)**

![Graph of ZEP 520A Spin curve (2)](image)

**Process Conditions**
- Substrate: 4 inch Si wafer
- Resist: ZEP 520A
- Spin: 300rpm 3sec → Xrpm 120sec
- PB temp: 180°C
- PB time: 3 min

**D.R.** (Resist+Solvent)/Resist (Weight Ratio)
8. Dependence on Prebake Temperature

Effect on Dose to Clear

Effect on Normalized Residual Thickness

Process Conditions
- Substrate: Si wafer
- Resist: ZEP520, ZEP520A
- Film thickness: 5000 Å
- PB time: 3 min
- Exposure: ELS3300, 20 kV
- Developer: ZED-N5Q, 23°C
- Dev. time: 1 min
- Rinse: ZMD-B, 23°C, 10 sec.
9. Dependence on Development Temperature

**Graph 1:**
- **ZEP-RD**
- **ZED-N50**
- **ZEP-SD**

**Process Conditions**
- Substrate: Si wafer
- Resist: ZEP520
- Film thickness: 5000Å
- PB temp: 180°C
- PB time: 3min.
- Exposure: ELS3300, 20kV
- Dev. time: 1min.
- Rinse: ZMD-B, 23°C, 10sec.

**Graph 2:**
- **ZEP-RD**
- **ZED-N50**
- **ZEP-SD**

**Process Conditions**
- Substrate: Si wafer
- Resist: ZEP520
- Film thickness: 5000Å
- PB temp: 180°C
- PB time: 3min.
- Exposure: ELS3300, 20kV
- Dev. time: 1min.
- Rinse: ZMD-B, 23°C, 10sec.
9. Dependence on Development Time

![Graph 1: Dose to clear (µC/sqcm) vs Development time (min)]

**Process Conditions**
- Substrate: Si wafer
- Resist: ZEP-520
- Film thickness: 5000 Å
- PB temp.: 180°C
- PB time: 3 min.
- Exposure: 5LS3000, 20 kV
- Dev. temp.: 23°C
- Rinse: ZMD-B, 23°C, 10 sec.

![Graph 2: Normalized residual thickness (%) vs Development time (min)]

**Process Conditions**
- Substrate: Si wafer
- Resist: ZEP-520
- Film thickness: 5000 Å
- PB temp.: 180°C
- PB time: 3 min.
- Exposure: 5LS3000, 20 kV
- Dev. temp.: 23°C
- Rinse: ZMD-B, 23°C, 10 sec.
10. Examples of application

0.15 μm Isolated space

Process Conditions
Resist : ZEP520
Film thickness : 5000 Å
PB temp. : 180°C
PB time : 2min.
Exposure : 30kV, 5 × 10^{-11} A, 1 line exp.
50 × 10^{-5} μC/cm
Dev. temp. : ZED-WN, 23°C, 30sec.

0.1 μm Isolated line

Process Conditions
Resist : ZEP520
Film thickness : 5000 Å
PB temp. : 180°C
PB time : 2min.
Exposure area : 100 μm^2 (20000 × 20000 dot)
Exposure : 30kV, 5 × 10^{-11} A, 1 line exp.
0.7 μsec/dot
Dev. temp. : ZED-WN, 23°C, 60sec.

0.05 μm Isolated space

Process Conditions
Resist : ZEP520
Film thickness : 15000 Å
Exposure : 75kV

These data were presented by ELIONIX INC.
11. Dry Etching Resistance

(1) CF₄ Dry Etching Rate

CF₄ Dry Etching Condition
0.15torr, 70sqcm, 200W

(2) Cl₂+O₂ Dry Etching Rate

Cl₂+O₂ Dry Etching Condition
Cl₂/O₂=4/1, 5min.
12. Example of Process Conditions

(1) Coating
   - ZEP520A: 2000rpm × 60sec → 5000 Å
   - ZEP520A-7: 2000rpm × 60sec → 3000 Å

(2) Prebake
   - 170～200°C × 20～30min. (Oven)
   - 170～200°C × 2～5min. (Hot Plate)

(3) Exposure
   - 20～50 μC/cm² at 20kV

(4) Development
   - 20～25°C × 60～360sec. (Dipping)
   - ZEP-RD, ZED-N50

(5) Rinse
   - 20～25°C × 10～60sec. (Dipping)
   - ZMD-B

(6) Post bake
   - in case of wet etching
   - 100～140°C × 20～30min. (Oven)
   - 100～140°C × 2～3min. (Hot Plate)

(7) De-scum
   - O₂-plasma (need be)

(8) Etching
   - Dry process and wet process can be used.

   Wet Etching solution for Cr
   - Ammonium cerium(IV) nitrate (NH₄)₂Ce(NO₃)₆: 13～18wt%
   - Perchloric acid HClO₄: 3～8wt%
   - Pure water H₂O: 77～84wt%

(9) Resist removing
   - <organic solvent>
     - Dimethylacetamide (DMAC): (30~35°C)
     - N-methyl-2-pyrroldone (NMP): (30~35°C)

   < deep-UV + organic solvent >
   - 1st step: 185nm+254nm, 10mW/cm², 3min.-irradiation
   - 2nd step:
     - Dimethylacetamide (DMAC) or N-methyl-2-pyrroldone (NMP),
     - 23°C × 1min.

*As the polymer of ZEP520A is decomposed by deep-UV irradiation, it can be easily removed.
13. Handling Precaution

(1) Flammable Liquid.
(2) Harmful by inhalation.
(3) Avoid contact with skin and eyes.

CAUTION: Open carefully. Use in well ventilated area. In case of contact with skin and eyes, rinse immediately with plenty of water for 15 minutes and get medical attention. In case of fire use Alcohol form CO₂ or dry chemical, never use water.

STORAGE: Keep capped and away from oxidants, sparks and open flame. Store at cool[32° F(0° C)~77° F(25° C)] and dark place. Use in clean room.
14. Appendix

(1) Refractive index of ZEP520A film

Cauchy coefficient
\[ n = n_0 + \frac{n_1}{\lambda^2} + \frac{n_2}{\lambda^4} \]
\[ n_0 = 1.541093 \]
\[ n_1 = 4.113002 \times 10^5 \]
\[ n_2 = 4.070357 \times 10^{12} \]
absorption coefficient = 0

unit of \( \lambda \) : Å
measured by UV-1250/SE (KLA Tencor)

(2) Glass transition temperature of ZEP520A polymer

\[ T_g : 105^\circ C \] measured by DSC