Technical Report

ZEON CORPORATION

ZEONREX Electronic Chemicals

ZEP520A

High Resolution Positive Electron Beam Resist

ZEON CORPORATION

Specialty Materials Division

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Tech
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>1QTT 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>1QTT 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>1GL bottle</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% Isopropyl alcohol 11%</td>
<td></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)

ZEP 520A Spin curve (2)

Process Conditions
- Substrate: 4-inch Si wafer
- Resist: ZEP520A
- 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-N50, 23°C
- Dev. time: 1 min
- Rinse: ZMD-B, 23°C, 10 sec.
9. Dependence on Development Temperature

![Graph showing Dependence on Development Temperature](image)

Process Conditions:
- Substrate: Si wafer
- Resist: ZEP520
- Film thickness: 5000Å
- PB temp: 180°C
- PB time: 3min.
- Exposure: ELS3900, 20kV
- Dev. time: 1min.
- Rinse: ZMD-B, 23°C, 10sec.

![Graph showing Normalized Residual Thickness](image)

Process Conditions:
- Substrate: Si wafer
- Resist: ZEP520
- Film thickness: 5000Å
- PB temp: 180°C
- PB time: 3min.
- Exposure: ELS3900, 20kV
- Dev. time: 1min.
- Rinse: ZMD-B, 23°C, 10sec.
9. Dependence on Development Time

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

Process Conditions
Substrate: Si wafer
Resist: ZEP520
Film thickness: 5000Å
PB temp: 180°C
PB time: 3min
Exposure: ELS3300, 20kV
Dev. temp: 23°C
Rinse: ZMD-B, 23°C, 10sec
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, $5 \times 10^{-11}$A, 1 line exp.
$50 \times 10^{-2} \mu C/cm$
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□ (20000 × 20000dot)
Exposure : 30kV, $5 \times 10^{-11}$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

![Graph showing CF₄ Dry Etching Rate comparison]

- ZEP series
- Competitor E
- Novolak Resist O

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

(2) Cl₂+O₂ Dry Etching Rate

![Graph showing Cl₂+O₂ Dry Etching Rate comparison]

- ZEP520
- Novolak Resist O

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 μ C/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 (if 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-pyrroldione(NMP) (30〜35°C)

< deep-UV + organic solvent >
1st step: 185nm+254nm,10mW/cm²,3min.-irradiation
2nd step:
Dimethylacetamide(DMAC) or N-methyl-2-pyrroldione (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 CO$_2$ 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

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