AZ ELECTRONIC MATERIALS PRESENTS

THE AZ® P4000-SERIES RESISTS FOR PLATING AND RECORDING HEAD APPLICATIONS

BU Electronic Materials
INTRODUCING THE P4000-SERIES RESISTS

- CHARACTERISTICS
- APPLICATIONS
- FEATURES AND BENEFITS
- TYPICAL PROCESSES
- PERFORMANCE

The information contained herein is, to the best of our knowledge, true and accurate, but all recommendations or suggestions are made without guarantee because the conditions of use are beyond our control. There is no implied warranty of merchantability or fitness for purpose of the product or products described here. In submitting this information, no liability is assumed or license or other rights expressed or implied given with respect to any existing or pending patent, patent application, or trademark. The observance of all regulations and patents is the responsibility of the user.

BU Electronic Materials
INTRODUCING THE P4000-SERIES RESISTS

- PRODUCTION-PROVEN FOR
  - MAGNETORESISTIVE (MR) AND INDUCTIVE THIN FILM RECORDING HEAD PLATING
  - AIR BEARING/SLIDER FABRICATION
  - TAPE-AUTOMATED BONDING AND C4 “FLIP CHIP” BUMPING PROCESSES

- VISCOSITY GRADES FOR FILM THICKNESS OF 1 TO 50 μm

- SPIN, SPRAY AND ROLLER COAT VERSIONS AVAILABLE FOR VARIETY OF SUBSTRATES

AZ® P4620 PHOTORESIST @ 6.5 μm : 1.5 μm L/S ON Si

BU Electronic Materials
AZ PHOTORESIST: THE BEST IN THICK FILM

AZ P4000-SERIES PHOTORESIST OFFERS....

Features
- Steep wall profiles and excellent adhesion on a wide variety of substrates
- Sensitive to g-, h- and i-line wavelengths
- Available in viscosities that allow coating thicknesses up to 50 μm
- Excellent ion milling properties
- Exceptionally stable cured films
- Cast in PGMEA “safer” solvent with no co-solvent

Benefits
- Ideal profile for up-plating
- Reduced rework
- No underplating even in thick films
- Fast photospeed on all popular exposure tools
- Single resist series that applies to wide range of applications
- High yields
- No cracking, peeling, or bubbling
- Provides an excellent, easy to use permanent insulator layer for critical high-reliability applications in thin film recording heads
- Toxicity hazard extremely low
- Provides excellent coating properties

BU Electronic Materials
SEVERAL GRADES AVAILABLE

Film Thickness (μ)

Spin Speed (RPM)

- P4903
- P4620
- P4400
- P4330-RS
- P4210
- P4110

BU Electronic Materials
# EXAMPLE OF 6.5 µm PROCESS

## Coat: Target 6.5 µm Film Thickness

<table>
<thead>
<tr>
<th>Event</th>
<th>Operation</th>
<th>Time</th>
<th>Speed</th>
<th>Accel</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SpinLS</td>
<td>2 sec</td>
<td>300 rpm</td>
<td>50 krpm/sec</td>
<td>Alert</td>
</tr>
<tr>
<td>2</td>
<td>spin LS</td>
<td>10 sec</td>
<td>0 rpm</td>
<td></td>
<td>dispense</td>
</tr>
<tr>
<td>3</td>
<td>SpinLS</td>
<td>3 sec</td>
<td>300 rpm</td>
<td>50 krpm/sec</td>
<td>disperse</td>
</tr>
<tr>
<td>4</td>
<td>SpinHS</td>
<td>60 sec</td>
<td>3900 rpm*</td>
<td>50 krpm/sec</td>
<td>coat</td>
</tr>
<tr>
<td>5</td>
<td>EBR</td>
<td>10 sec</td>
<td>500 rpm</td>
<td>50 krpm/sec</td>
<td>EBR</td>
</tr>
<tr>
<td>6</td>
<td>SpinHS</td>
<td>10 sec</td>
<td>1000 rpm</td>
<td>50 krpm/sec</td>
<td>Dry</td>
</tr>
</tbody>
</table>

* Estimated rpm

## Softbake: 110°C

<table>
<thead>
<tr>
<th>Event</th>
<th>Operation</th>
<th>Time</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gap *</td>
<td>10 sec</td>
<td>0.001</td>
</tr>
<tr>
<td>2</td>
<td>Bake</td>
<td>120 sec</td>
<td>Full Contact</td>
</tr>
</tbody>
</table>

* Gap used to imitate slow heating of substrate

Use 120 sec Bake if Gap function not available

## Develop Program:

### Constant Spray at 27.0°C

<table>
<thead>
<tr>
<th>Event</th>
<th>Operation</th>
<th>Time</th>
<th>Speed</th>
<th>Accel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Spray *</td>
<td>180 sec</td>
<td>250 rpm</td>
<td>50 krpm/sec</td>
</tr>
<tr>
<td>2</td>
<td>Rinse</td>
<td>20 sec</td>
<td>300 rpm</td>
<td>50 krpm/sec</td>
</tr>
<tr>
<td>3</td>
<td>Dry</td>
<td>15 sec</td>
<td>4000 rpm</td>
<td>50 krpm/sec</td>
</tr>
</tbody>
</table>

* 140 ml of Developer per min

Delay times required of 30-45 minutes after softbake, and 30 min. after exposure

---

**BU Electronic Materials**
PERFORMANCE OF
THE AZ® P4000 PHOTORESIST

AZ® P4620 PHOTORESIST
Linearity on Silicon at 350 mJ/cm², 6.5 micron film thickness

Dense Lines
SB: 110°C/120 sec
Ultratech 1500
AZ® 400K Developer 1:4/180 sec spray

BU Electronic Materials
PERFORMANCE OF
THE AZ® P4000 PHOTORESIST

AZ® P4620 PHOTORESIST
5.0 μm L/S Exposure Latitude on Silicon, 6.5 micron film thickness

![Graph showing measured linewidth vs. exposure dose]

- Measured Linewidth [μm]
- Exposure Dose [mJ/cm²]

315 mJ/cm²
62% Exposure Latitude

Dense Lines
SB: 110°C/120 sec; Ultratech 1500
AZ® 400KDeveloper 1:4/180 sec spray

BU Electronic Materials
PERFORMANCE OF
THE AZ® P4000 PHOTORESIST

BOSSUNG PLOT, AZ® P4620 PHOTORESIST
4.0 μm L/S on Silicon, 6.5 micron film thickness

Dense Lines
SB: 110°C/120 sec
Ultratech 1500
AZ® 400K Developer 1:4/180 sec

BU Electronic Materials
EXAMPLE OF 24 μm PROCESS

Coating Process:

**First Coat: Target 10 μm Film Thickness**

<table>
<thead>
<tr>
<th>Event</th>
<th>Operation</th>
<th>Time</th>
<th>Speed</th>
<th>Accel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SpinLS</td>
<td>2 sec</td>
<td>300 rpm</td>
<td>50 krpm/sec</td>
</tr>
<tr>
<td>2</td>
<td>spin LS</td>
<td>10 sec</td>
<td>0 rpm</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SpinLS</td>
<td>3 sec</td>
<td>300 rpm</td>
<td>50 krpm/sec</td>
</tr>
<tr>
<td>4</td>
<td>SpinHS</td>
<td>60 sec</td>
<td>2100 rpm*</td>
<td>50 krpm/sec</td>
</tr>
<tr>
<td>5</td>
<td>EBR</td>
<td>10 sec</td>
<td>500 rpm</td>
<td>50 krpm/sec</td>
</tr>
<tr>
<td>6</td>
<td>SpinHS</td>
<td>10 sec</td>
<td>1000 rpm</td>
<td>50 krpm/sec</td>
</tr>
</tbody>
</table>

* Estimated rpm

**Second Coat: Target 24.0 μm Total Film Thickness**

<table>
<thead>
<tr>
<th>Event</th>
<th>Operation</th>
<th>Time</th>
<th>Speed</th>
<th>Accel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SpinLS</td>
<td>2 sec</td>
<td>300 rpm</td>
<td>50 krpm/sec</td>
</tr>
<tr>
<td>2</td>
<td>spin LS</td>
<td>10 sec</td>
<td>0 rpm</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SpinLS</td>
<td>3 sec</td>
<td>300 rpm</td>
<td>50 krpm/sec</td>
</tr>
<tr>
<td>4</td>
<td>SpinHS</td>
<td>60 sec</td>
<td>900 rpm*</td>
<td>50 krpm/sec</td>
</tr>
<tr>
<td>5</td>
<td>EBR</td>
<td>10 sec</td>
<td>500 rpm</td>
<td>50 krpm/sec</td>
</tr>
<tr>
<td>6</td>
<td>SpinHS</td>
<td>10 sec</td>
<td>1000 rpm</td>
<td>50 krpm/sec</td>
</tr>
</tbody>
</table>

* Estimated rpm

**First Softbake: 110°C**

<table>
<thead>
<tr>
<th>Event</th>
<th>Operation</th>
<th>Time</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gap  *</td>
<td>10 sec</td>
<td>0.001</td>
</tr>
<tr>
<td>2</td>
<td>Bake</td>
<td>80 sec</td>
<td>Full Contact</td>
</tr>
</tbody>
</table>

* Gap used to imitate slow heating of substrate

Use 85 sec Bake if Gap function not available

**Second Softbake: 110°C**

<table>
<thead>
<tr>
<th>Event</th>
<th>Operation</th>
<th>Time</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gap  *</td>
<td>10 sec</td>
<td>0.001</td>
</tr>
<tr>
<td>2</td>
<td>Bake</td>
<td>160 sec</td>
<td>Full Contact</td>
</tr>
</tbody>
</table>

* Gap used to imitate slow heating of substrate

Use 165 sec Bake if Gap function not available

**Develop Program:**

**Constant Spray at 27.0°C**

<table>
<thead>
<tr>
<th>Event</th>
<th>Operation</th>
<th>Time</th>
<th>Speed</th>
<th>Accel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Spray  *</td>
<td>260 sec</td>
<td>250 rpm</td>
<td>50 krpm/sec</td>
</tr>
<tr>
<td>2</td>
<td>Rinse</td>
<td>20 sec</td>
<td>300 rpm</td>
<td>50 krpm/sec</td>
</tr>
<tr>
<td>3</td>
<td>Dry</td>
<td>15 sec</td>
<td>4000 rpm</td>
<td>50 krpm/sec</td>
</tr>
</tbody>
</table>

* 140 ml of Developer per min

Delay times required of 60 min. after last bake, and 30 min. after exposure

NOTE: RECOMMENDATIONS FOR SINGLE-COAT PROCESSES ALSO AVAILABLE

**BU Electronic Materials**
AZ® P4620 PHOTORESIST

Linearity on Silicon at 1600 mJ/cm², 24 micron Film Thickness

Dense Lines
Double Coat/SB: 110°C
Ultratech 1500
AZ® 400K Developer 1:4/260 sec spray

BU Electronic Materials
PERFORMANCE OF
THE AZ® P4000 PHOTORESIST

AZ® P4620 PHOTORESIST
9.0 μm L/S Exposure Latitude on Silicon, 24 micron Film Thickness

1600 mJ/cm²
21% Exposure Latitude

Dense Lines
Double Coat/SB: 110°C; Ultratech 1500
AZ® 400KDeveloper 1:4/260 sec spray

BU Electronic Materials
PERFORMANCE OF THE AZ® P4000 PHOTORESIST

BOSSUNG PLOT, AZ® P4620 PHOTORESIST
9.0 μm L/S on Silicon, 24 micron film thickness

Dense Lines
Double Coat/SB: 110°C
Ultratech 1500
AZ® 400K Developer 1:4/260 sec

BU Electronic Materials
Thermal Comparison of Thick Film Photodetectors

125°C
120°C
115°C
110°C
No Bake

SB: 110°C, 240 sec
AZ® P4620

24 µm F.T. using Two Coat Process on Silicon Wafer. Results after 2 min.
PERFORMANCE OF THE AZ® P4000 PHOTORESISTS

- PERFORMANCE COMPARISON OF AZ® P4620 PHOTORESIST USING SPRAY AND IMMERSION DEVELOPMENT AT 22°C AND 27°C.

<table>
<thead>
<tr>
<th>Develop Conditions</th>
<th>DTP (mJ/cm²)</th>
<th>Exposure Latitude</th>
<th>Resolution (µm)</th>
<th>DOF (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27°C, Spray</td>
<td>1263</td>
<td>11%</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>27°C, Immer.</td>
<td>1284</td>
<td>26%</td>
<td>4.5</td>
<td>14</td>
</tr>
<tr>
<td>22°C, Spray</td>
<td>1221</td>
<td>6%</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>22°C, Immer.</td>
<td>1456</td>
<td>21%</td>
<td>4</td>
<td>14</td>
</tr>
</tbody>
</table>

24 µm RESIST ON SILICON
ULTRATECH 1500
SOFTBAKE 110 ºC, 240 SEC.
260 SEC. SPRAY OR IMMERSION USING AZ® 400K DEVELOPER 1:4

BU Electronic Materials
PERFORMANCE OF THE AZ® P4000 PHOTORESISTS

<table>
<thead>
<tr>
<th>Refractive Index</th>
<th>365</th>
<th>405</th>
<th>435</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleached</td>
<td>1.7173</td>
<td>1.6902</td>
<td>1.6796</td>
</tr>
<tr>
<td>k</td>
<td>0.0020</td>
<td>0.0014</td>
<td>0.0100</td>
</tr>
<tr>
<td>Unbleached</td>
<td>1.7150</td>
<td>1.7017</td>
<td>1.6963</td>
</tr>
<tr>
<td>k</td>
<td>0.0203</td>
<td>0.0207</td>
<td>0.0150</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cauchy Constants</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Thk. (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleached</td>
<td>1.6207</td>
<td>0.0029136</td>
<td>2.78E-03</td>
<td>2010.3</td>
</tr>
<tr>
<td>Unbleached</td>
<td>1.6154</td>
<td>0.010349</td>
<td>8.16E-04</td>
<td>2018.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dill Parameters</th>
<th>365</th>
<th>405</th>
<th>435</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (μm⁻¹)</td>
<td>0.6117</td>
<td>0.5901</td>
<td>0.3697</td>
</tr>
<tr>
<td>B (μm⁻¹)</td>
<td>0.0427</td>
<td>0.0318</td>
<td>0.0243</td>
</tr>
<tr>
<td>C (cm²/mJ)</td>
<td>0.0270</td>
<td>0.0285</td>
<td>0.0203</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bake Conditions</th>
<th>Temp (°C)</th>
<th>Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Bake</td>
<td>110</td>
<td>60</td>
</tr>
<tr>
<td>PEB Bake</td>
<td>110</td>
<td>60</td>
</tr>
</tbody>
</table>

BU Electronic Materials
AZ® P4000 Bleached Absorbance Curve

AZ P4000 Series resist(s)
Ellipsometric Absorbance
Normalized to 1/µm

Absorbance ('k')

Wavelength (nm)

BU Electronic Materials
AZ® P4000 Unbleached Absorbance Curve

AZ P4000 Series resist(s)
Ellipsometric Absorbance
Normalized to 1/µm

Absorbance ('k')

Wavelength (nm)

'k' ellipsometric: P4000

BU Electronic Materials
<table>
<thead>
<tr>
<th>Cure Temp.</th>
<th>Dielectric Constant</th>
<th>Breakdown Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 °C</td>
<td>AZ P4620 4.02</td>
<td>AZ P4620 629</td>
</tr>
<tr>
<td>225 °C</td>
<td>AZ P4620 4.09</td>
<td>AZ P4620 693</td>
</tr>
<tr>
<td>250 °C</td>
<td>AZ P4620 4.58</td>
<td>AZ P4620 674</td>
</tr>
</tbody>
</table>

BU Electronic Materials
AZ® P4000 PHOTORESIST AGING DATA

AZ®P4620 Resist Lot # J7651 Aging Study

% PS Vs. Ref

Time


Room Temp.

Normal Storage Cond.(refer)

BU Electronic Materials
LET THE AZ TEAM SERVE YOUR THICK RESIST REQUIREMENTS

- GLOBAL INFRASTRUCTURE TO SUPPORT YOUR WORLDWIDE BUSINESS WITH EXPANDING LOCAL SUPPORT NETWORKS
- EXPERIENCED PHOTORESIST SUPPLIER TO THE THIN FILM RECORDING HEAD INDUSTRY
  - IMAGING IN THICK FILMS, RESIST PLATING (CU, AU), ADHESION, CURING
- EXCELLENT PERFORMANCE AND VALUE IN ALL OUR PRODUCTS AND SERVICES
- WIDE SELECTION OF SOLUTIONS TO YOUR PROBLEMS

BU Electronic Materials