HPR 500
SAFER SOLVENT
POSITIVE RESIST SERIES

HPR 500 Series resists are positive working resists for semiconductor application, having suitable properties for use as a mask for ion implant, wet and dry etching. HPR 500 Series resists perform in a wide range of developer conditions, MIF or MIC, using track or immersion systems. The HPR 500 Series resist range gives spin coatings ranging from 1.0 - 2.2µ.

How you benefit

* The solvent used in HPR 500 Series resists is ethyl lactate (2-hydroxy ethyl propionate). It is a safer solvent compared to those previously used in resist products.

* HPR 500 Series resists have wide process latitude and are suitable for a wide range of process applications giving you a repeatable on-line process.

* As with all OCG's resist products, HPR 500 Series resists are supported by local offices with their administration and technical sales staff, together with a field force of product specialists who have access to our Technical Service Centre, providing you with the service and the back-up that you require.

Inside

How to use HPR 500 Series resists

Product specification

Contact address and phone numbers
Spin Coating

A choice of viscosities / solids content

HPR 500 Series resists are available in several viscosities providing a range of film thicknesses as shown in figure 1.

![Graph showing film thickness vs spin speed for different HPR resists](image)

- **Substrate**: Si
- **Spin coat**: Dispense 3s static (S.V.G. track) Pause: 1s
  Spread: 3s / 500 rpm (30 krpm/s)
  Spin: 25 s (30 krpm/s)
- **Softbake**: 110°C for 50s H.P.
- **Measurement**: Nanospec AFT

Figure 1: Spin curves for HPR 500 Series resists

The substrate must be clean and dry to ensure coating quality, optimum adhesion, and process consistency.
**Good adhesion**

HPR 500 Series resists have good adhesion properties, and surface priming may not be necessary on all masking layers. HPR 500 Series resists are also compatible with silylating pretreatments, so adhesion promoters such as HMDS can be used on those substrates that require such treatment.

However, contact with any residual HMDS vapour or liquid, causes a noticeable decrease in photospeed.

**Uniform spin coating**

Various coating cycles can be employed with HPR 500 Series depending on your particular requirements. Using the following spin program with HPR 504 resulted in a coating uniformity sigma of 65 Å, on a 4" wafer.

<table>
<thead>
<tr>
<th>Step</th>
<th>Time</th>
<th>rpm</th>
<th>Accl</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispense</td>
<td>2 s</td>
<td>0*</td>
<td>0</td>
<td>2.5 ml</td>
</tr>
<tr>
<td>Pause</td>
<td>1 s</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Spread</td>
<td>2 s</td>
<td>500</td>
<td>1 K rpm/s</td>
<td>-</td>
</tr>
<tr>
<td>Spin</td>
<td>20 s**</td>
<td>5 K rpm/s</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

**Edge bead removal**

Resist edge bead removal can be successfully achieved using RER 500. An example of a typical process is given below using an SVG Model 8626 photoresist coater. The process removed 1.5 mm of edge bead from 4" wafers coated with 1.2μ of HPR 504 resist on SiO₂.

<table>
<thead>
<tr>
<th>Step</th>
<th>Time</th>
<th>Spinspeed (rpm)</th>
<th>Acceleration (rpm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spin</td>
<td>2</td>
<td>300</td>
<td>10,000</td>
</tr>
<tr>
<td>Dispense</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RER 500</td>
<td>10</td>
<td>300</td>
<td>10,000</td>
</tr>
<tr>
<td>Spin</td>
<td>2</td>
<td>300</td>
<td>10,000</td>
</tr>
<tr>
<td>Spin Dry</td>
<td>10</td>
<td>3000</td>
<td>2,000</td>
</tr>
</tbody>
</table>

**Other settings**

- Exhaust: 1.5 inches
- Dispense nozzle size: 0.064 inches
- Nozzle placement: 10mm from wafer edge
- Metering valve setting: 2.25
- Dispense pressure: 60 oz/inch (3.75 psi)

**Comments for higher viscosities**

* When using HPR 506, HPR 507 and HPR 508 it is recommended that a dynamic dispense method is used to gain optimum uniformity with the thicker coatings obtained.

** To ensure that the bulk of the solvent is removed prior to softbake, it is recommended that this final spin time is increased by 10 seconds for spin coatings thicker than 1.8μ.
Softbake

The purpose of this bake is to remove residual solvent left over after coating, and to promote adhesion between resist and coated substrate.

Recommended Conditions

<table>
<thead>
<tr>
<th>Resist</th>
<th>Hot plate bake time</th>
<th>Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPR 504/5</td>
<td>40 - 60s</td>
<td>100 ± 10°C</td>
</tr>
<tr>
<td>HPR 506/7</td>
<td>60 - 90s</td>
<td>100 ± 10°C</td>
</tr>
</tbody>
</table>

HPR 500 Series resists can be softbaked using convection oven, track oven, or hotplate systems. Lower softbake temperatures give higher photospeed, while higher temperatures improve adhesion.

Figure 2 gives an indication of the soft bake latitude of HPR 500 Series resists, showing the critical dimension change with softbake temperature.

Figure 2: $\Delta CD$ vs softbake temperature for 1.2$\mu$m thick HPR 504
g-line stepper exposure

HPR 500 Series resists may be used with contact, projection and stepper exposure equipment, using g- or h-line, or broadband sources.

HPR 500 Series offers good photospeed with HPRD developers maximizing throughput without reducing process latitude.

Figures 3 to 7 show g-line stepper data.

Figure 3 shows a sinusoidal exposure curve generated using a GCA DSW 4800 stepper and the HPR 504 / HPRD 428 system in a double puddle development mode. It is a guideline for the exposure energy required for different resist film thicknesses.

![Figure 3](image)

Figure 4 compares g-line stepper exposure latitude for different developer series.

![Figure 4](image)

<table>
<thead>
<tr>
<th>Developer</th>
<th>Latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPRD-428</td>
<td>0.003μmJ/cm²</td>
</tr>
<tr>
<td>HPRD-437</td>
<td>0.002μmJ/cm²</td>
</tr>
</tbody>
</table>

Conditions:
- Substrate: Si
- Spin coat: 1.2μ HPR 504
- Softbake: 90°C H.P. 60s
- Exposure: Canon MKII 0.43NA
- Post exposure bake: 115°C HP 60s
- Develop: 5/45s Single Puddle
- Feature: 0.8μ
Figure 5 shows 1μ lines and spaces, easily obtainable in production from the system HPR 504 / HPRD 428, using a 0.30 NA g-line stepper.

Figure 5: 1μ lines and spaces in HPR 504 developed with HPRD 428

HPR 504 exhibits linearity at optimum exposure down to submicron geometries as can be seen from Figure 6.

Figure 6: HPR 504 linearity to mask dimension

Substrate : 0.6μ SiO₂
Spin coat : Nominal 1.28 μ
Softbake : 110°C HP
Exposure : GCA DSW 4800
           | 240 mJ/cm²
Develop  : HPRD 428
           | 2/20/2/25s
           | double puddle
Measurement: ITP System 80

Substrate : Silicon
Spin coat : 2.2μ HPR506
Softbake : 100°C HP, 60s
Exposure : CANON MKII 0.43NA
Develop  : HPRD 429
           | 2/16s single puddle

Figure 7
Projection exposure

The information on this page gives an example of the exposure latitude and resolution that can be expected using scanning mirror projection systems.

Figure 8 shows 3μ lines and spaces, printed in HPR 506 using the conditions listed below.

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Silicon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spin coat</td>
<td>Nominal 1.85 μ</td>
</tr>
<tr>
<td>Softbake</td>
<td>110³C, 50 s, HP</td>
</tr>
<tr>
<td>Exposure</td>
<td>Micralign 230</td>
</tr>
<tr>
<td>Develop</td>
<td>HPRD 419</td>
</tr>
<tr>
<td></td>
<td>Immersion, 60 s</td>
</tr>
</tbody>
</table>

![Figure 8](image)

Figure 9: CD variation using HPRD 402 - projection exposure

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Si O₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spin coat</td>
<td>Nominal 1.1μ HPR 504</td>
</tr>
<tr>
<td>Softbake</td>
<td>105³C HP 45 s</td>
</tr>
<tr>
<td>Exposure</td>
<td>Micralign 230</td>
</tr>
<tr>
<td>Develop</td>
<td>Spray puddle with HPRD 402 (18 second dwell)</td>
</tr>
<tr>
<td>Measurement</td>
<td>Hitachi MF68</td>
</tr>
<tr>
<td>Feature size</td>
<td>3μ window</td>
</tr>
</tbody>
</table>
Develop

Choices of MIF & MIC, for track or tank

Either metal-ion containing or metal-ion free developers are available for HPR 500 Series. Tank or track developer systems can be used successfully.

Developers available are listed below:

<table>
<thead>
<tr>
<th>Product</th>
<th>Type</th>
<th>Normality</th>
<th>Application</th>
<th>Typical Dwell/Immersion time</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPRD 419</td>
<td>MIC</td>
<td>.23</td>
<td>Tank</td>
<td>60 to 90 s</td>
</tr>
<tr>
<td>HPRD 402</td>
<td>MIF</td>
<td>.33</td>
<td>Track</td>
<td>15 to 25 s</td>
</tr>
<tr>
<td>HPRD 428</td>
<td>MIF</td>
<td>.25</td>
<td>Track</td>
<td>40 to 50 s or 20 to 25 s double puddle</td>
</tr>
<tr>
<td>HPRD 429</td>
<td>MIF</td>
<td>.31</td>
<td>Track</td>
<td>15 to 25 s</td>
</tr>
<tr>
<td>HPRD 437</td>
<td>MIF</td>
<td>.25</td>
<td>Track</td>
<td>40 to 50 s or 20 to 25 s double puddle</td>
</tr>
</tbody>
</table>

Hardbake

The purpose of this bake is generally to improve image stability, adhesion and chemical/plasma resistance.

Recommended conditions:

<table>
<thead>
<tr>
<th>Method</th>
<th>Time</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convection</td>
<td>20 to 30 min</td>
<td>120 ± 5°C</td>
</tr>
<tr>
<td>Hotplate</td>
<td>40 to 60 s</td>
<td>120 ± 5°C</td>
</tr>
</tbody>
</table>

Thermal stability

HPR 500 Series resists have good thermal stability, even higher temperatures can be implemented after standard deep UV treatment. Image size, image bulk, and process conditions / methods, all have an influence on thermal stability.
**Ion implant**

**Stopping power**

HPR 500 Series resists can be used as a mask during ion implantation of Phosphorus, Boron, Arsenic, etc. using various doses. Typical applications include channel stop implant, emitter-collector implant, extrinsic base layer implant, threshold adjustment, selective source-drain implantation.

**Wet etch**

**Wet chemical resistance**

HPR 500 Series resists have suitable chemical resistance for successful wet etch processes, and is used as a mask to wet etch doped / undoped oxides, polysilicon and aluminium.

**Resist strip**

HPR 500 Series resist can be effectively stripped using Microstrip 2001.

Microstrip 2001 is a non-phenolic and non-chlorinated stripper.

Alternatives are:
- Suitable solvents (if the resist has not seen temperatures above 110°C).
- Hot mineral oxidizing acid cleaning mixtures. (eg. Sulfuric / Peroxide, Nitric).
- Oxygen Plasma Equipment

Review the OCG Microstrip 2001 product bulletin.

**Dry etch**

**Good selectivity**

HPR 500 Series resists also have suitable plasma etch resistance to give good selectivity in plasma etch processes.

HPR 500 Series can be used in both PE and RIE mode with either Fluorine or Chlorine based gas chemistries. Patterning with HPR 504 can be applied to most thin films requiring dry etching in the manufacture of semiconductor devices on silicon or III V substrates (eg. polysilicon, Si O₂, silicides, aluminum and its alloys, silicon nitride, Ga As etc.).

![Figure 10](image)

Figure 10 shows HPR 506 used as a mask during dry etching of Al/Si (1%). Single wafer etcher (Balzers SWE 654) was used in plasma mode, with a SiCl₄/Cl₂ based gas chemistry.
Technical data

<table>
<thead>
<tr>
<th></th>
<th>HPR504</th>
<th>HPR 505</th>
<th>HPR506</th>
<th>HPR 507</th>
<th>HPR 508</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids (%)</td>
<td>Min</td>
<td>25.5</td>
<td>28.3</td>
<td>31.2</td>
<td>34.2</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>26.5</td>
<td>29.3</td>
<td>32.2</td>
<td>35.2</td>
</tr>
<tr>
<td>Viscosity (cps)</td>
<td>Min</td>
<td>36.0</td>
<td>50.0</td>
<td>90.0</td>
<td>150.0</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>40.0</td>
<td>56.0</td>
<td>100.0</td>
<td>170.0</td>
</tr>
<tr>
<td>Water Content</td>
<td>&lt; 0.5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filtration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refractive Index</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash Point</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Trace Metals

<table>
<thead>
<tr>
<th>Impurity</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>&lt; 200 ppb</td>
</tr>
<tr>
<td>K</td>
<td>&lt; 200 ppb</td>
</tr>
<tr>
<td>Cu</td>
<td>&lt; 125 ppb</td>
</tr>
<tr>
<td>Zn</td>
<td>&lt; 35 ppb</td>
</tr>
<tr>
<td>Fe</td>
<td>&lt; 200 ppb</td>
</tr>
<tr>
<td>Ni</td>
<td>&lt; 35 ppb</td>
</tr>
<tr>
<td>Ca</td>
<td>&lt; 100 ppb</td>
</tr>
<tr>
<td>Al</td>
<td>&lt; 100 ppb</td>
</tr>
</tbody>
</table>

OCG resist products are subjected to stringent production tests to ensure consistent performance and purity.

Certificates of analysis

Certificates of Analysis are available for each production batch. Each certificate details the relevant analytical and functional specifications together with the measured results. Analytical data includes solids content, viscosity and impurity levels. Functional test data shows film thickness and photospeed results.
General

Unit size: HPR 500 Series resists are shipped in 4l bottles to minimize bottle change frequency.

Storage: It is recommended that HPR 500 Series resists are stored in temperature controlled areas at approx. 10°C when storing for an extended period of time (e.g. longer than 1 month). In general protect from heat and light.

Shelf-life: One year from date of manufacture, if stored between 4 and 10°C in original sealed container.

Safety: Review the Material Safety Data Sheet thoroughly before using this product. This gives information on: Normal handling procedures; hazardous ingredients; fire, explosion, and health hazard data; toxacology; procedures for dealing with spills / leakages; shipping, reactivity and physical data. HPR 500 Series resists contain organic solvents, store in a well ventilated area away from all sources of ignition. Adequate ventilation during coating and stripping is necessary to maintain vapour concentrations within acceptable safety limits. Use only in strict accordance to your facility's safety requirements.

Compatibility: HPR 500 Series resists are compatible with most commercially available photoresist processing equipment. Compatible materials include stainless steel, glass, ceramic, high density polyethylene, high density polypropylene, Teflon, or equivalent material.

Further information available


The Chemistry and Technology of Positive Photoresists. A. Stein


More processing information can be obtained from your local OCG representative.
For analytical test methods contact your local OCG representative.
Production SQC-data is available contact your local OCG representative.
Headquarters

EUROPE
OCG MICROELECTRONIC MATERIALS N.V.
KEETBERGLAAN 1A
HAVENNUMMER 1061
2070 ZWIJNDRECHT, BELGIUM
TEL.: +32 (0)3 250 05 11
TELEFAX: +32 (0)3 252 46 31
TELEX: 32.500 OCG B

JAPAN
FUJI-HUNT ELECTRONICS TECHNOLOGY LTD
38th KOWA BUILDING
12-24 NISHIAZUBA 4-CHOME
MINATU-KU TOKYO 106, JAPAN
TEL.: 334 06 69 11
TELEFAX: 334 98 05 67
TELEX: 242 7041

U.S.A.
OCG MICROELECTRONIC MATERIALS
3, GARRET MOUNTAIN PLAZA
WEST PATerson, N.J. 07424 USA
TEL.: 201 / 977 60 00
TELEFAX: 201 / 977 61 10
TELEX: 42 30 80 HUNT WPAT

Technical Service Centers

OCG MICROELECTRONIC MATERIALS
TECHNICAL SERVICE CENTER
KEETBERGLAAN 1A
HAVENNUMMER 1061
2070 ZWIJNDRECHT, BELGIUM
TEL.: +32 (0)3 250 05 11
TELEFAX: +32 (0)3 252 46 31
TELEX: 32.500 OCG B

OCG MICROELECTRONIC MATERIALS
CUSTOMER SUPPORT CENTER
1025 SOUTH 52ND STREET
TEMPE, ARIZONA 85281 USA
TEL.: 602 / 829.1010
TELEFAX: 602 / 921 08 31

Subsidiaries Europe

ITALY
OCG MICROELECTRONIC MATERIALS S.R.L.
VIA DEI MILLE 5 / A
I - 200 98 S. GIULIANO MILANESE MI, ITALY
TEL.: 2 98 24 10 60
TELEFAX: 2 984 78 08
TELEX: 35 24 43

GERMANY
OCG MICROELECTRONIC MATERIALS
KRONSTADTERSTRASSE 9
D-8000 MÜNCHEN 80
TEL.: 089 93 30 01
TELEFAX: 089 93 02 123

SCOTLAND / IRELAND
OCG MICROELECTRONIC MATERIALS
29 LANGLANDS PLACE
KELVIN SOUTH INDUSTRIAL EST.
EAST KILBRIDE
GLASGOW G75 OYF
SCOTLAND
TEL.: 035 52 47 913
TELEFAX: 035 52 47 914

FRANCE
OCG MICROELECTRONIC MATERIALS SA
ZAC PARIx NORD II
209 A.V. DES NATIONS
BP 60019 F95970 ROISSY CDG CEDEX
TEL.: 148 63 21 66
TELEFAX: 148 63 22 23
TELEX: 23 39 81

SALES OFFICE GERMANY
OCG MICROELECTRONIC MATERIALS GmbH
RHEINSTR. 38
D-6083 BÜTTELBORN O.T. WORFELDEN
TEL.: 06152 84335
TELEFAX: 06152 84451

U.K. SALES OFFICE
OCG MICROELECTRONIC MATERIALS LTD
SITE 7, KIDDERMINSTER ROAD
CUTNALL GREEN
DROITWICH
WORCESTERSHIRE WR9 ONS
TEL.: 02 992 33 44
TELEFAX: 02 992 32 22