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KMPR 1000
Chemically Amplified Negative Photoresist

KMPR 1000 i-Line photoresist is a high contrast, epoxy based photoresist that can be developed in a conventional aqueous alkaline developer (TMAH) and readily stripped from the wafer. KMPR is designed to coat 4 – 120 μm in a single step using the four standard viscosities. KMPR 1000 has excellent adhesion, chemical and plasma resistance, making it ideal for many MEMS, Electrolytic Plating and DRIE applications.

Features

- High aspect ratio imaging
- Vertical sidewalls
- Greater than 100 μm film thickness in a single coat
- Aqueous developer compatible (TMAH & KOH)
- Wet strips in conventional strippers
- Excellent dry etch resistance

Processing Guidelines

KMPR 1000 is most commonly exposed with conventional UV (350-400 nm) radiation, although i-line (365 nm) is recommended. It may also be exposed with e-beam or x-ray radiation. Upon exposure, cross-linking proceeds in two steps (1) formation of a strong acid during the exposure step, followed by (2) acid-initiated, thermally driven cross-linking during the post exposure bake (PEB) step. A normal process is: spin coat, soft bake, expose, PEB, followed by develop.

Substrate Preparation

To obtain maximum process reliability, substrates should be clean and dry prior to applying KMPR 1000 resist. For best results, substrates should be cleaned with a piranha wet etch (using H_2SO_4 & H_2O_2) followed by a de-ionized water rinse. Substrates may also be cleaned using reactive ion etching (RIE) or any barrel asher supplied with O_2 gas. Adhesion promoters are typically not required. For applications that require electroplating it is recommended to pre-treat the substrate with MCC Primer 80/20 (HMDS).

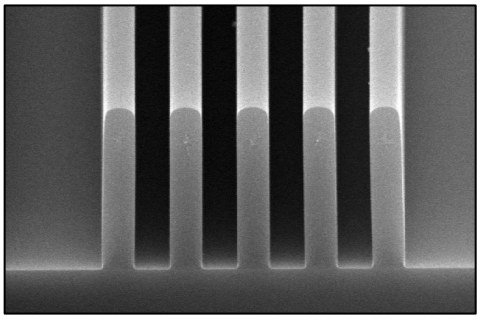
Coat

KMPR 1000 resists are available in four standard viscosities, shown in Table 1. Figures 1 and 2 provide the information required to select the appropriate KMPR 1000 resist and spin conditions, to achieve the desired film thickness.

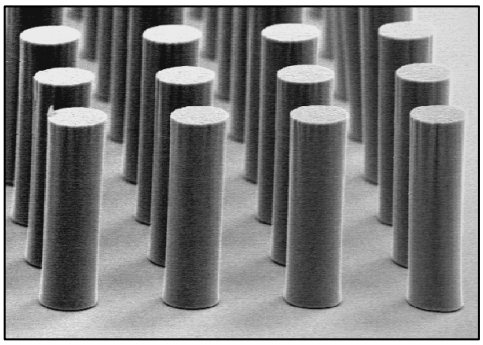
Recommended Program

(1) Dispense 1ml of resist for each inch (25mm) of substrate diameter
(2) Spin at 500 rpm for 5-10 sec with acceleration of 100 rpm/second
(3) Spin at 3000 rpm for 30 sec with acceleration of 300 rpm/second

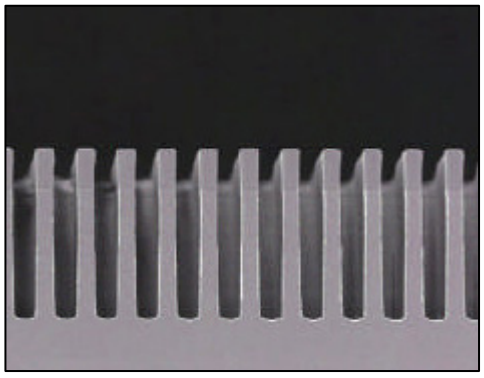
Applications



i-Line stepper exposure
2 μm features, 10 μm KMPR coating



Copper Plated Deposit
10 μm features, 45 μm tall



Etched Trenches
10 μm features, 65 μm deep
(Photo Courtesy of ULVAC)

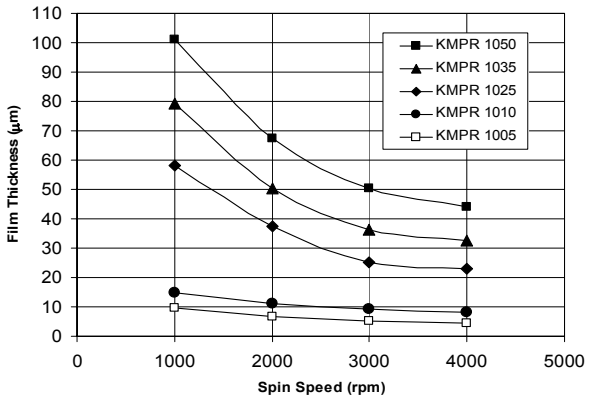


Figure 1. Spin speed vs. Thickness
for KMPR 1000 resists (21°C US & EU)

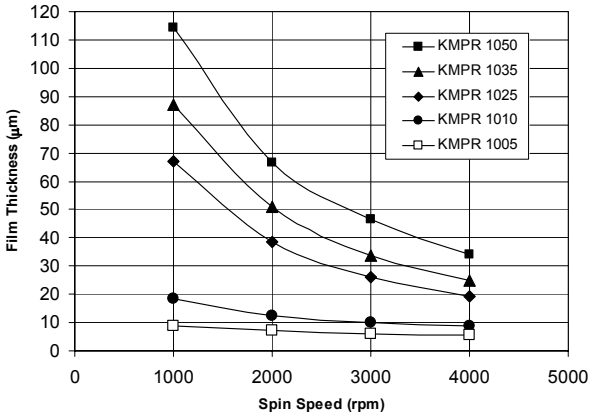


Figure 2. Spin speed vs. Thickness
for KMPR 1000 resists (23°C Japan & Asia)

Table 1. KMPR Viscosity

KMPR	% Solids	Viscosity (cSt)
1005	45	95
1010	55	600
1025	63.8	4800
1035	66	8300
1050	67.3	13000

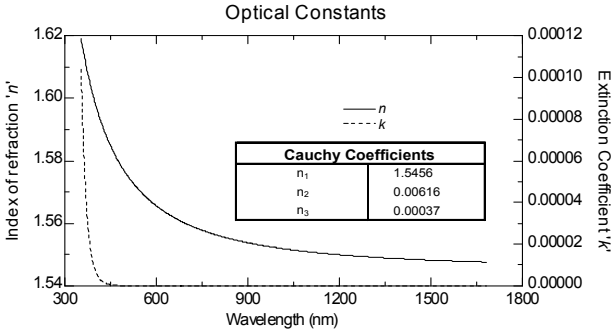


Figure 3. Cauchy Coefficients

Soft Bake

A level hotplate with good thermal control and uniformity is recommended for use during the Soft Bake step of the process. Convection ovens are not recommended. During convection oven baking, a skin may form on the resist. This skin can inhibit the evolution of solvent, resulting in incomplete drying of the film and/or extended bake times. Table 2 shows the recommended Soft Bake temperatures and times for the various KMPR 1000 products at selected film thicknesses. The recommended bake temperature is 100°C, however temperatures from 95-105°C may also be used.

Note: *In order to optimize the baking times/conditions, remove the wafer from the hotplate after the prescribed time and allow to cool to room temperature. Then, return the wafer to the hotplate. If the film 'wrinkles', leave the wafer on the hotplate for a few more minutes. Repeat the cool-down and heat-up cycle until 'wrinkles' are no longer seen in the film when the wafer is initially placed on the hotplate.*

The dispersion curve and Cauchy coefficients are shown in Figure 3. This information is useful for film thickness measurements based on optical ellipsomety.

THICKNESS microns	SOFT BAKE TIME minutes @ 100°C
5 - 11	5
12 - 20	7
21 - 30	12
31 - 55	15
56 - 80	20

Table 2. Soft Bake Times

Exposure

To obtain vertical sidewalls in the KMPR 1000 resist, we recommend the use of a long pass filter to eliminate UV radiation below 350 nm. With the recommended filter (PL-360-LP) from Omega Optical (www.omegafilters.com) or Asahi Technoglass filters V-42 *plus* UV-D35 (www.atgc.co.jp), an increase in exposure time of approximately 40% is required to reach the optimum exposure dose.

Note: *Optimal exposure will produce a visible latent image after being placed on the PEB hotplate and not before. A visible latent image before the PEB step indicates excessive exposure. An exposure matrix experiment should be performed to optimize the exposure dose*

THICKNESS microns	EXPOSURE ENERGY mJ/cm^2
5 - 11	235 - 335
12 - 20	355 - 485
21 - 30	500 - 645
31 - 55	665 - 1055
56 - 80	1070 - 1465

Table 3. Exposure Dose

	RELATIVE DOSE
Silicon	1X
Glass	1.5X
Pyrex	1.5X
Indium Tin Oxide	1.5X
Silicon Nitride	1.5 - 2X
Gold	1.5 - 2X
Aluminum	1.5 - 2X
Nickel Iron	1.5 - 2X
Copper	1.5 - 2X
Nickel	1.5 - 2X
Titanium	1.5 - 2X

Table 4. Exposure Doses for Substrates

Post Exposure Bake (PEB)

Should take place directly after exposure and before development. For KMPR 1000 film thicknesses of 25 μm or less, a PEB time of 2 minutes at 100°C is sufficient. For Film thickness greater than 25 μm, a PEB time of 3 minutes is recommended. For Film thickness greater than 50 μm, a PEB time of 4 minutes is recommended. The recommended PEB temperature is 100°C, however temperatures from 95-105°C may also be used.

Note: *After 1 minute of PEB, an image of the mask should be visible in the KMPR photoresist coating. No visible latent image during or after PEB means that there was insufficient exposure, temperature or both.*

Develop

KMPR 1000 resist has been designed for use with 2.38% TMAH (0.26N) aqueous alkaline developer in immersion, spray or spray-puddle processes. Other solvent based developers such as SU-8 developer may also be used instead of TMAH. Strong agitation during development is recommended for high aspect ratio and/or thick film structures. Recommended develop times for immersion processes are given in Table 5 for TMAH and Table 6 for SU-8 developer. These develop times are approximate, since actual dissolution rates can vary widely as a function of agitation

Note: The use of an ultrasonic or megasonic bath is helpful for developing out photoresist vias or holes.

THICKNESS	TMAH DEVELOPMENT TIME
microns	minutes
5 - 11	3
12 - 20	5
21 - 30	6
31 - 55	6
56 - 80	8

Table 5. Development Times for 2.38% TMAH

THICKNESS	SU-8 DEVELOPMENT TIME
microns	minutes
5 - 11	2
12 - 20	2
21 - 30	2
31 - 55	3
56 - 80	4

Table 6. Development Times for SU-8 Developer

Rinse and Dry

Following TMAH development, the substrate should be spray rinsed with de-ionized water for 20 seconds and then air dried with filtered, pressurized air or nitrogen.

When using SU-8 developer, spray/wash the developed image with fresh developer solution for approximately 10 seconds, followed by a second spray/wash with Isopropyl Alcohol (IPA) for another 10 seconds. Air dry with filtered, pressurized air or nitrogen.

Note: *A white film produced during IPA rinse indicates that the substrate has been under developed. Simply immerse or spray the substrate with SU-8 developer to remove the film and complete the development process. Repeat the rinse step.*

Plating

(1) HMDS
(2) Coat, Expose, PEB, Develop
(3) Descum: RIE 2 min, 100 W, 10 sccm O_2, 100 mTorr
(4) Electrolytic Copper: 60 min, 0.1 A/dm^2

Note: *Hard bake is NOT REQUIRED OR RECOMMENDED for plating resistance.*

Removal

KMPR 1000 will swell and lift and readily strip using MicroChem's Remover PG (NMP). To remove KMPR 1000 with Remover PG, heat the bath to 80°C and immerse the substrates for 10-20 minutes. Actual strip time will depend on resist thickness and agitation method (such as ultrasound). For more information on MicroChem Remover PG please see the relevant product data sheets.

Note: *An optional 10 min soak in DMSO at 80°C prior to the Remover PG bath and the use of high pressure, Remover PG spray at 45 psi, after the Remover PG bath is also recommended.*

Plasma Removal

RIE 200W, 80 sccm O_2, 8 sccm CF_4, 100mTorr, 10°C

Storage

Store KMPR 1000 resists *frozen* in tightly closed, upright containers at 14°F(-10°C). Store away from light, heat, acids and sources of ignition. Shelf life is twelve months from the date of manufacture for storage at 14°F(-10°C) and typically one to two months at room temperature. Defrost KMPR 1000 at room temperature for 24 hours prior to use.

Disposal

KMPR 1000 resists may be included with other waste containing similar organic solvents to be discarded for destruction or reclaim in accordance with local state and federal regulations. It is the responsibility of the customer to ensure the disposal of KMPR 1000 resists and residues made in observance all federal, state, and local environmental regulations.

Environmental, Health and Safety

Consult the product Material Safety Data Sheet before working with KMPR 1000 resists. Handle with care. Wear chemical goggles, chemical gloves and suitable protective clothing when handling KMPR 1000 resists. Do not get into eyes, or onto skin or clothing. Use with adequate ventilation to avoid breathing vapors or mist. In case of contact with skin, wash affected area with soap and water. In case of contact with eyes, rinse immediately with water and flush for 15 minutes lifting eyelids frequently. Get emergency medical assistance.

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