KMPR® 1000

Chemically Amplified Negative Photoresist

Description

KMPR® 1000 i-Line photoresist is a high contrast, epoxy based photoresist that can be developed in a conventional aqueous alkaline developer (TMAH) and more easily removed after normal processing. KMPR® is designed to coat 4–110 µm in a single step using the five 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 stripping in conventional strippers
- Excellent dry etch resistance

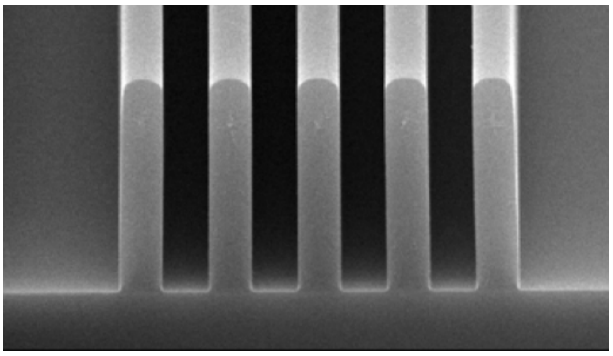
Processing Guidelines

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.

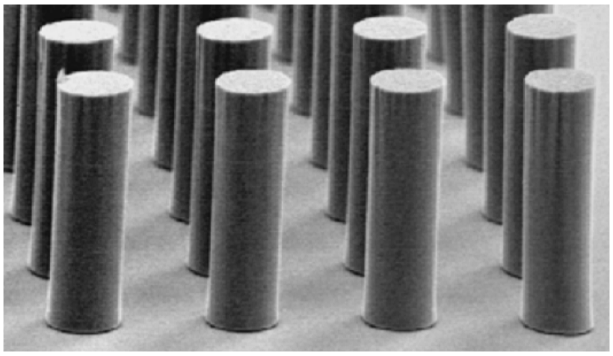
Substrate Preparation

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

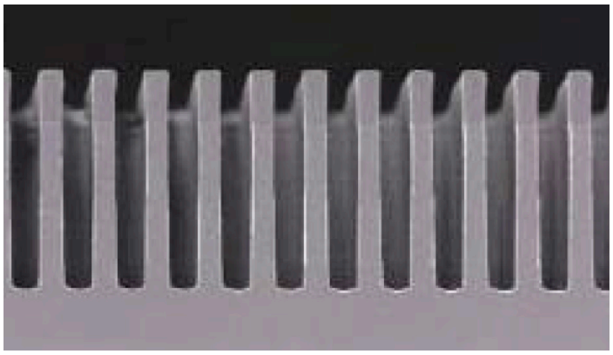
Applications



i-Line Stepper Exposure
2 µm features, 10 µm KMPR® coating



Copper Plated Pillars
10 µm features, 45 µm tall, KMPR® removed



(PHOTO COURTESY OF ULVAC)

Etched Trenches
10 µm features, 65 µm deep

promoters are typically not required. For applications that require electroplating, it is recommended to pre-treat the substrate with HMDS Primer.

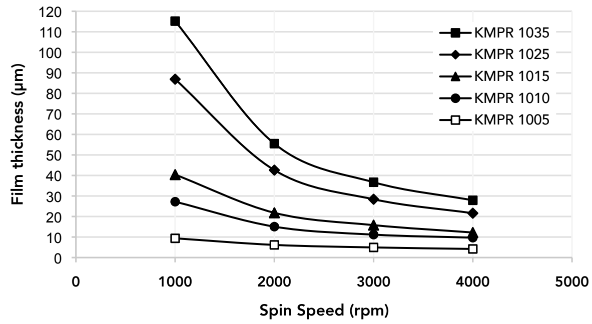


Figure 1. KMPR® 1000 Thickness vs. Spin Speed

KMPR	% Solids	Viscosity (cSt)
1005	45	95
1010	55	600
1015	60	1900
1025	64	5200
1035	65	8400

Table 1. KMPR Viscosity

Coat

KMPR® 1000 resists are available in five standard viscosities, as shown in Table 1. Figure 1 provides the information required to select the appropriate KMPR® 1000 resist and spin conditions, to achieve the desired film thickness.

Recommended Program

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

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 temperature 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.

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

Optical Parameters

The dispersion curve and Cauchy coefficients are shown in Figure 2. This information is useful for film thickness measurements based on ellipsometry and other optical measurements.

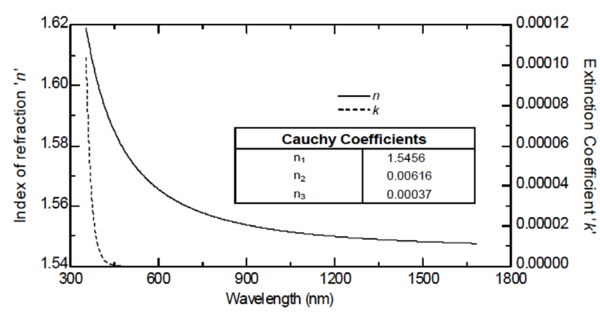


Figure 2. Cauchy Coefficients

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Exposure

To obtain vertical sidewalls in the KMPR® 1000 resist, we recommend the use of a longpass filter to eliminate UV radiation below 350 nm. With the recommended filter (PL-360LP), 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)

A post exposure bake (PEB) is required to complete the curing reaction and should take place directly after exposure. Table 5 shows the recommended times and temperature for various approximate thickness targets. The recommended 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® 1000 photoresist coating. No visible latent image during or after PEB means that there was insufficient exposure, temperature or both.

THICKNESS microns	**PEB TIME** minutes @ 100ºC
≤ 25	2
25 – 50	3
≥ 50	4

Table 5. PEB Times

Development

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 6 for TMAH and Table 7 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.

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

Table 6. Development Times for 2.38% TMAH

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

Table 7. 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 minutes, 100 W, 10 sccm O_2, 100 mTorr
(4) Electrolytic Copper: 60 min, 0.1 A/dm^2

Note: Hard bake is NOT REQUIRED NOR RECOMMENDED for plating resistance.

Removal

When processed without a hard bake, KMPR® 1000 will swell and lift and readily strip using Kayaku Advanced Materials' 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 Kayaku Advanced Materials' Remover PG please see the product data sheet.

Process Recommendation

(1) Remover PG: 10 minutes, 80°C
(2) DI water rinse
(3) Plasma removal if required

Plasma Removal

RIE 200W, 80 sccm O_2, 8 sccm CF_4, 100 mTorr, 10°C. *For more information, refer to the SU-8 / KMPR® Removal applications note on the website www.kayakuAM.com. Also see www.r3t.de or www.tepla.com for microwave plasma tools for high throughput without damaging other microstructures.*

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 thirteen 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.

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Handling

Consult Safety Data Sheet (SDS) for details on the handling procedures and product hazards prior to use. If you have any questions regarding handling precautions or product hazards, please email *productsafety@kayakuAM.com.*

Disposal

The material and its container must be disposed in accordance with all local, state, federal and/or international regulations.

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