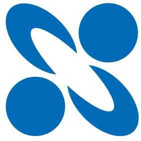
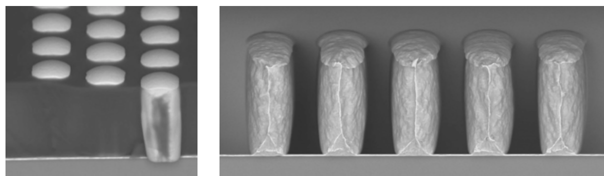


TempKoat™ P

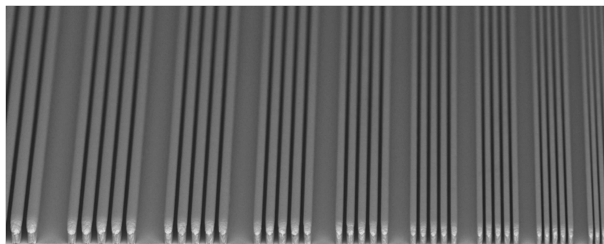
Positive-tone Temporary Photoresist

Description

TempKoat™ P is a chemically amplified, positive-tone, temporary resist formulated for advanced packaging and MEMS applications. Specifically, TempKoat™ P is capable of producing high aspect ratio features from thick, single coatings. The unique combination of photospeed and resolution, while maintaining excellent chemical resistance and residue-free removal, make it ideal for state-of-the-art advanced packaging. TempKoat™ P 20 is the first dilution available in the TempKoat™ P series.



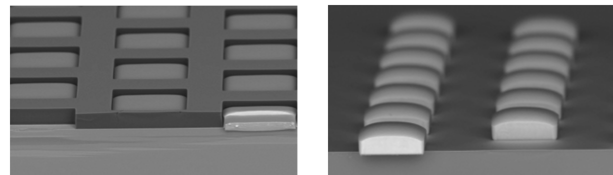
Copper plated posts (left) lines and spaces (right) – 10 µm features plated to 33 µm – TempKoat™ P stripped on right image



Copper plated lines and spaces – 14 to 6 µm (left to right) features plated to 30 µm – TempKoat™ P stripped

Features

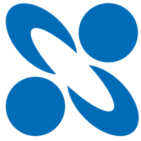
- 3:1 achievable aspect ratio
- Single coat thickness capability 10 to 40 µm
- No rehydration delay or latency post exposure
- Excellent chemical resistance
- Applications: electroplating, RDL, microbumping



Copper plated post – 100 µm features plated to 20 µm

Copper plated post – 50 µm features plated to 20 µm – TempKoat™ P stripped

Process Flow



PROCESSING GUIDELINES

TempKoat™ P is processed with exposures using near UV (350-450 nm) radiation. The resist is compatible with either i-Line (365 nm) or broadband (ghi-Line) radiation, as well as bulk exposure with a 360 nm long pass filter. The incident radiation causes the release of a catalytic acid. This chemical reaction is thermally activated during the post exposure bake (PEB), and acts to increase the solubility of the resist to aqueous developers.

Normal lithographic process flow: spin coat, edge bead removal, softbake, expose, post expose bake (PEB), and develop. There is no need for a hardbake step as the unexposed resist is chemically resistant and meant to be removed post processing. If a hardbake step is desired, hardbake temperature should not exceed 125°C. Process optimization is necessary for each specific application for peak resist performance. TempKoat™ P 20 is optimized for plating deposits from 10 to 20 µm thick. This document provides a baseline process as a starting point.

Substrate Preparation

Substrates should be clean and dry prior to TempKoat™ P application. Start with a solvent cleaning step or a short rinse with dilute acid, followed by a DI water rinse. To dehydrate the surface, bake at 200°C for 5 minutes in a vacuum oven. Substrates may also be cleaned using reactive ion etching (RIE) or any barrel asher supplied with O_2 gas. For applications on bare Si, a HMDS (Hexamethyldisilazane) vapor priming is recommended following a wafer dehydration step in the vacuum oven.

Coat

TempKoat™ P 20 is optimized for coating thicknesses from 10 to 25 µm. The resist is capable of coatings with minimal thickness variation. The film thickness versus spin speed data displayed in Table 1 and Figure 1 provide the information to select the appropriate TempKoat™ P 20 spin conditions. This will allow the user to achieve the desired film thickness.

Recommended Coating Conditions

(1) Static/Dynamic Dispense: Approximately 1ml of TempKoat™ P per inch of substrate diameter.
(2) Spread Cycle: Ramp to 1000 rpm at 1000 rpm/second acceleration. Immediately move to spin cycle step, no hold time necessary.
(3) Spin Cycle: Ramp to final spin speed at an acceleration of 1000 rpm/second and hold for a total of 30 seconds.

VISCOSITY cSt	THICKNESS microns	SPIN SPEED rpm
2200	11	4000
	15	3000
	20	2000
	40	1000

Table 1. Approximate Thickness vs. Spin Speed Data for TempKoat™ P 20

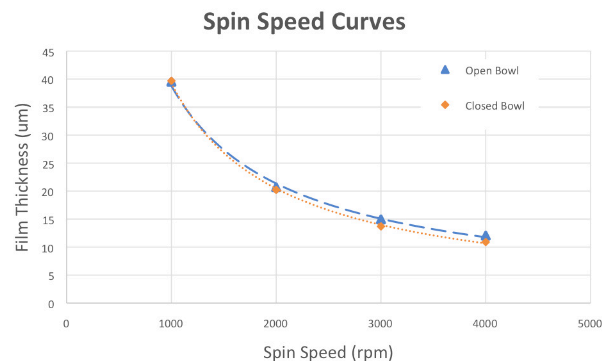


Figure 1. Thickness vs. Spin Speed for Open and Closed Bowl Conditions

Edge Bead Removal (EBR) and Softbake

An edge bead removal step can be done immediately following spin coating using Kayaku Advanced Materials' EBR PG. Following the edge bead removal, the remaining solvent must be evaporated by softbaking. This will densify the film. TempKoat™ P

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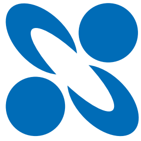

should be baked on a level, contact hotplate. For thicknesses up to 20 μm, it is not necessary to ramp or step-up softbake temperature.

THICKNESS microns	SOFTBAKE TIME minutes @ 120°C
≤20	3
25–40	5

Table 2. Recommended Softbake Parameters

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.

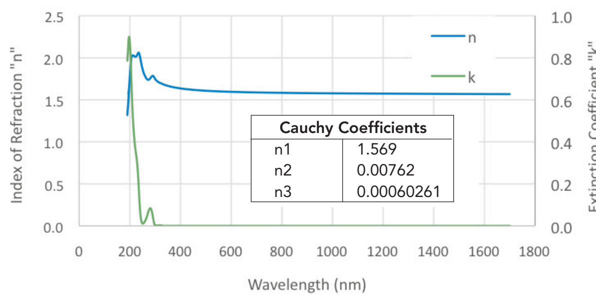

Figure 2. Cauchy Coefficients

Exposure

TempKoat™ P 20 is optimized for near UV (350-450 nm) exposure. The resist responds optimally to i-Line exposure. The resist is much less sensitive to h and g-Line radiation; however, exposure conditions for a 20 μm thick resist coating are listed in Table 3. The processing window identifying the exposure latitude can be found in the subsequent section for both Silicon and Copper substrates. Exposure dose recommendations are based on source intensity measurements taken with an i-Line (365 nm) radiometer and probe for both the Hg lamp contact aligner and stepper. The stepper ghi-Line is calibrated with a 400 nm OAI probe.

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.

Exposure Tip: When using a broad spectral output source, for best imaging results, i.e. straightest sidewalls, filter out higher energy wavelengths below 360 nm.

Radiation Source	Filter/Line	Opening Dose (Cu) mJ/cm^2	Opening Dose (Bare Si) mJ/cm^2
Stepper	i-Line	300	110
Stepper	ghi-Line (bulk)	550	400
Aligner	360 nm Cutoff	350	120
Aligner	No Filter	200	60

Table 3. Exposure Conditions for Stepper and Aligner with Various Spectrum Filters (20 μm film thickness)

All values present approximate opening doses for bulk exposed areas

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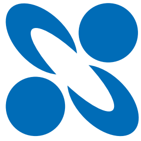
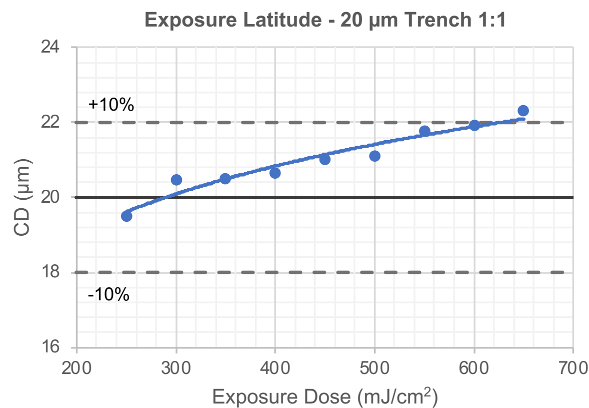
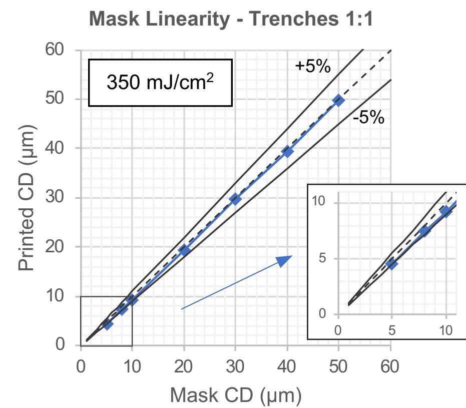


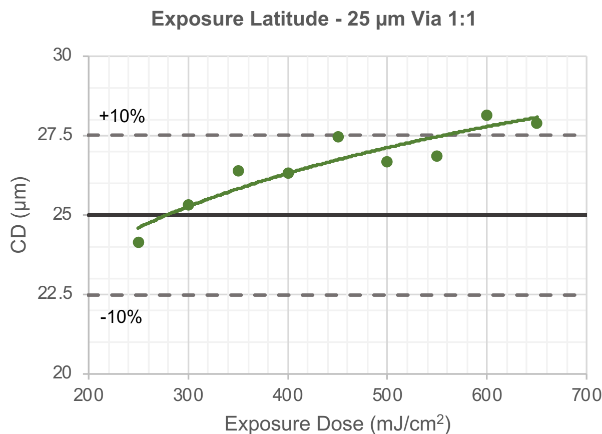
Processing Window

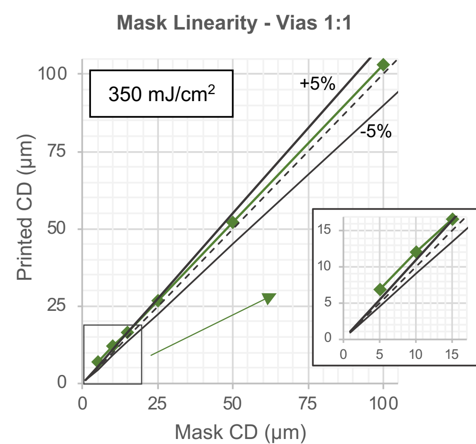
Processing window for exposure latitude and mask linearity on Copper

Exposure (20 µm film thickness on Cu)









Coated Thickness: 20 µm on PVD Cu wafer
Soft Bake: 120°C/3 min contact hot plate
Exposure: ABM Broadband mask aligner with 360 nm long pass filter (hard contact)
Intensity measured at 365 nm
Post Exposure Bake: 95°C/2 min contact hot plate
Develop: CD-26 Developer 4 x 60 sec puddles

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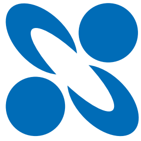
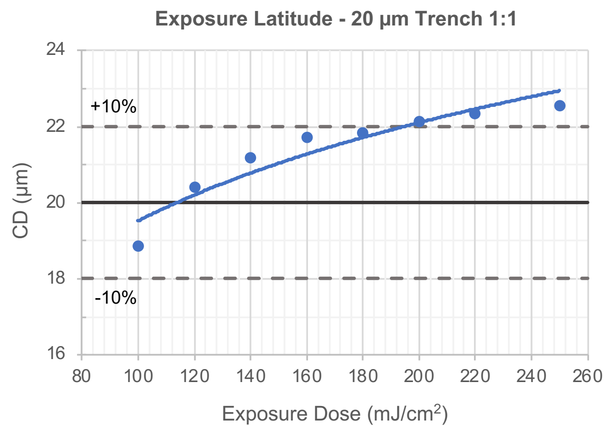
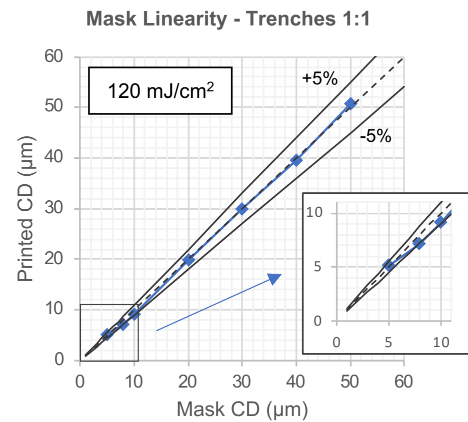


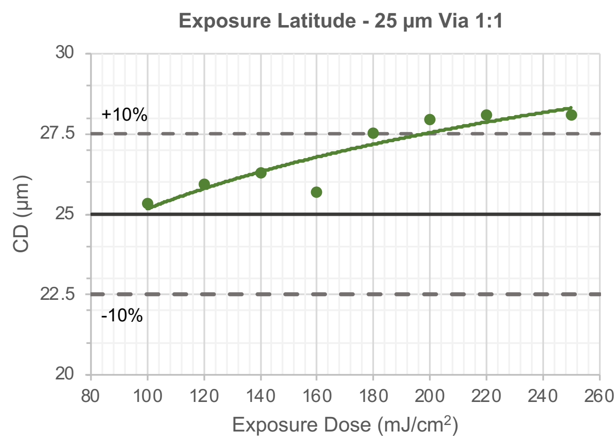
Processing Window

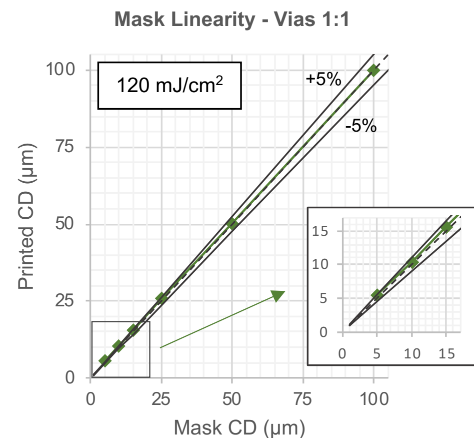
Processing window for exposure latitude and mask linearity on Silicon.

Exposure (20 µm film thickness on Si)









Coated Thickness: 20 µm on Si wafer
Soft Bake: 120°C/3 min contact hot plate
Exposure: ABM Broadband mask aligner with 360 nm long pass filter (hard contact)
Intensity measured at 365 nm
Post Exposure Bake: 120°C/2 min contact hot plate
Develop: CD-26 Developer 4 x 60 sec puddles

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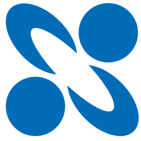

Post Exposure Bake (PEB)

A post exposure bake is necessary as it initiates the thermally driven, catalytic reaction to induce resist solubility to developers. PEB should quickly follow exposure, no latency is required for hydration. Table 4 has the recommended PEB temperature and time for a 20 μm thick TempKoat™ P film. PEB optimization may be necessary for changes in film thickness and exposure dose.

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

SUBSTRATE	PEB TEMPERATURE °C	PEB TIME minutes
Bare Si	115	2
PVD Cu on Si	95	2

Table 4. PEB Temperature and Time for Si and Cu Substrates

Development

TempKoat™ P resist has been designed for use with 2.38% TMAH (0.26N) aqueous alkaline developer. Many alkaline based developers are compatible with TempKoat™ P, including surfactant and surfactant-free variations of both metal-ion-bearing and metal-ion-free developers, see Table 5. Process optimization is necessary for different developer chemistries to achieve desired performance. Spray development is recommended with four separate 1-minute puddle steps. Immersion and continuous spray processes for development can be implemented but require user optimization. Increased development time or agitation are not recommended to improve residue removal. Additional exposure or increased PEB temperature or time are the best processing variables to improve feature shape and residue removal.

Developer	Chemistry	Concentration	Surfactant
CD-26	TMAH	0.26N	No
MF-26A	TMAH	0.26N	Yes
MF-319	TMAH	0.24N	Yes
MCC-303A	NaOH	1.7N	Yes

Table 5. List of Developers Confirmed to be Compatible with TempKoat™ P

Rinse and Dry

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

Plating

(1) Coat, Expose, PEB, Develop
(2) Descum: O_2 Plasma or RIE 3 minutes, 350W, 80 sccm O_2
(3) Oxide Removal: 15% dilute Technic Elevate® Cu 6300 immersion for 1.5 minutes
(4) Electrolytic Copper: 15-20 min at 50 Amps/ft^2*

**Note:* *For optimal plating results, Kayaku Advanced Materials recommends that plating current density be ≥ 50ASF for deposit thicknesses greater than 15 μm. Any questions regarding plating processing should be discussed with your Kayaku Advanced Materials Applications Product Specialist.*

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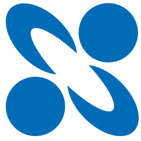

Removal

As TempKoat™ P is formulated to be a temporary resist, it is completely soluble in organic solvents. For optimal removal with minimum effect on plated features, stripping should be performed with Kayaku Advanced Materials' Remover PG (NMP). A 15-minute, agitated immersion at room temperature is sufficient to completely remove TempKoat™ P. To prevent drying stains, 20-second IPA rinse and DI water rinse, followed by drying using nitrogen is recommended.

Storage

Store TempKoat™ P resist upright in tightly closed containers in a cool, dry environment away from direct sunlight at a temperature of 50-77°F (10-25°C). Store away from light, acids, heat and sources of ignition. Shelf life is thirteen months from date of manufacture.

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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