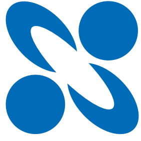
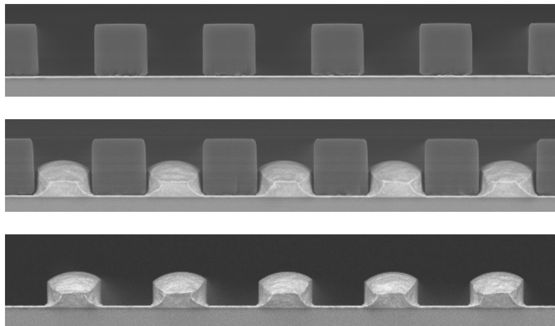


TempKoat™ N

Negative-tone Temporary Resist

Description

TempKoat™ N is a chemically amplified, negative-tone, temporary resist formulated for advanced packaging and MEMS applications. Specifically, TempKoat™ N is capable of producing high-aspect ratio features with minimal processing time. The unique combination of fast photospeed and high resolution, while maintaining excellent chemical resistance and residue-free removal, make it ideal for state-of-the-art advanced packaging. TempKoat™ N 15 is the first dilution available in the TempKoat™ N series.*



15 µm trenches in 15 µm thick TempKoat™ N before and after copper plating and resist removal

Features

- 2:1 achievable aspect ratio
- Single coat thickness capability 7 to 20 µm
- No rehydration delay or latency post exposure
- Excellent chemical resistance
- Applications: electroplating, RDL & microbumping

Process Flow

** Note: Product not commercially available within the United States; however, small scale quantities may be purchased in the United States for R&D purposes*

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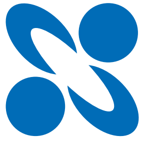

PROCESSING GUIDELINES

TempKoat™ N 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 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 decrease the solubility of the exposed resist to aqueous developers.

Normal lithographic process flow: spin coat, soft bake, expose, post expose bake (PEB), and develop. There is no need for a hard bake step as the exposed resist is chemically resistant and meant to be removed post processing. Process optimization is necessary for each specific application for peak resist performance. This resist is optimized for plating deposits from 5 to 15 µm thick. This document provides a baseline process as a starting point.

Substrate Preparation

Substrates should be clean and dry prior to TempKoat™ N 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 on a hot plate. Substrates may also be cleaned using reactive ion etching (RIE) or any barrel asher supplied with O_2 gas. For applications on bare Si, an HMDS (Hexamethyldisilazane) vapor priming is recommended following a wafer dehydration in the vacuum oven.

Coat

TempKoat™ N 15 is optimized for thick resist applications from 7 to 20 µm. The resist is capable of extremely low defect 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™ N 15 spin speed conditions to achieve the desired coating thickness.

Recommended Coating Conditions

(1) Static Dispense: Approximately 1 ml of TempKoat™ N 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
1100	7	4000
	10	3000
	15	2000
	20	1400

Table 1. Approximate Thickness vs. Spin Speed Data for TempKoat™ N 15

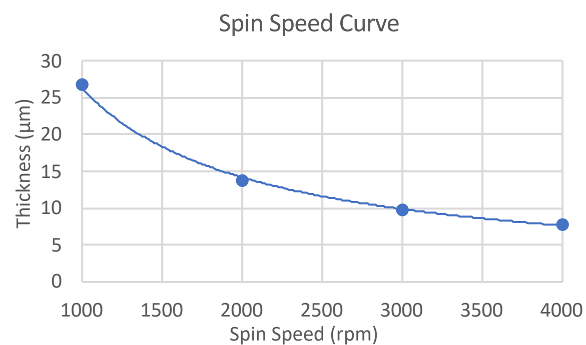

Figure 1. Thickness vs. Spin Speed (open and closed bowl)

Soft Bake and Edge Bead Removal (EBR)

Following the dispensing and spin coating of the resist, the remaining solvent must be evaporated by soft baking to densify the film. TempKoat™ N should be baked on a level, contact hot plate. An optional edge bead removal step can be done immediately

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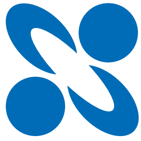

following soft bake using Kayaku's EBR PG. A 65°C bake for a minimum of 1 minute is necessary to drive off any remaining solvent following EBR.

THICKNESS microns	SOFT BAKE TIME minutes @ 115°C
10–20	3.5

Table 2. Recommended Soft Bake 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.

TempKoat™ N Optical Constants

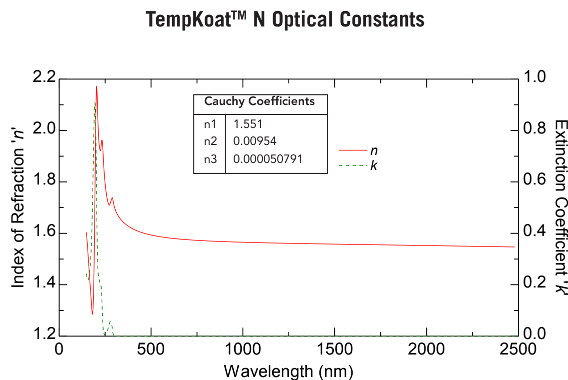

Figure 2. Cauchy Coefficients

Exposure

TempKoat™ N 15 is optimized for near UV (350-450 nm) exposure. The resist responds optimally to i-Line exposure and is much less sensitive to h and g-Line radiation. Exposure conditions for a 15 µm thick resist coating are listed for multiple exposure wave-length ranges in Table 3. The processing window identifying the exposure latitude can be found in the subsequent section for both copper and silicon substrates. Exposure dose recommendations are based on source intensity measurements taken with an i-Line (365 nm) radiometer and probe for the Hg lamp contact aligner.

Note: Optimal exposure will produce a visible latent image after being placed on the PEB hot plate 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 side-walls, filter out excessive energy below 360 nm.

Radiation Source	Filter/Line	Opening Dose (Cu) mJ/cm²	Opening Dose (Bare Si) mJ/cm²
Aligner	360 nm Cutoff	85	85
Aligner	No Filter	85	85

Table 3. Exposure Conditions for Contact Aligner With and Without Filter (15 µm Film Thickness)

All values present approximate starting doses

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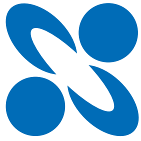
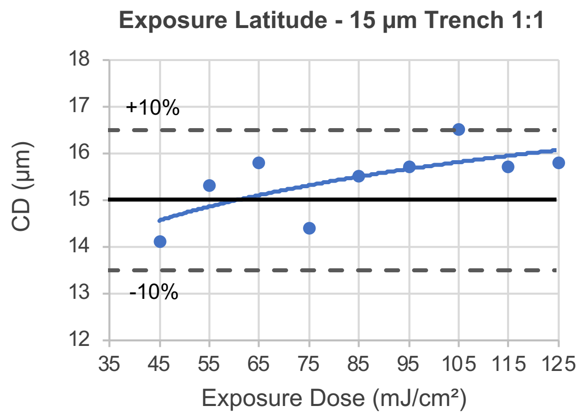
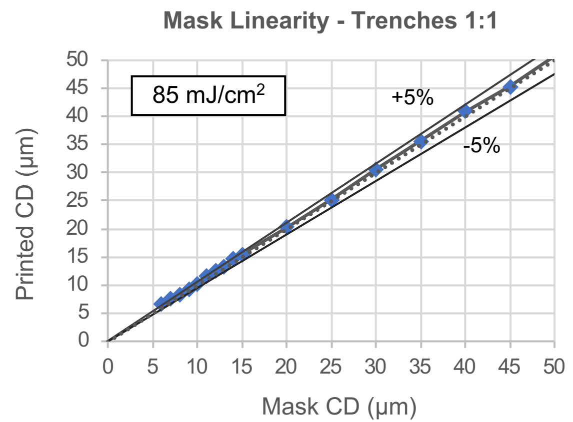


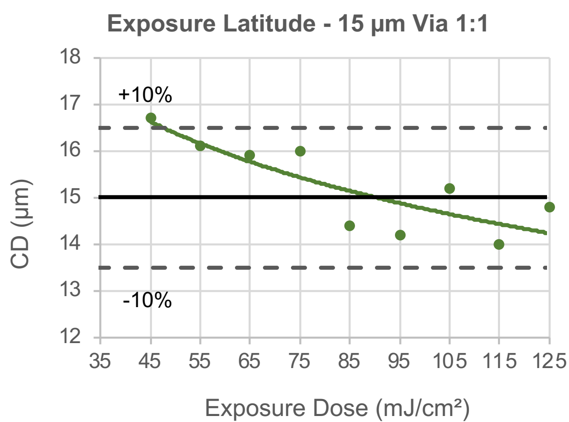
Processing Window

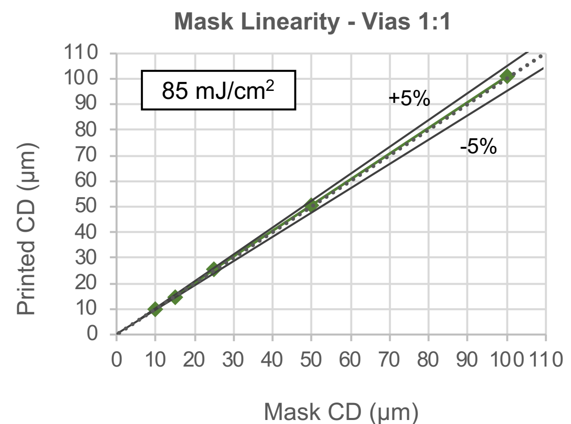
Processing window for exposure latitude and mask linearity on copper.

Exposure (15 µm film thickness on Cu)









Coated Thickness: 15 µm on PVD Cu wafer
Soft Bake: 115°C/3.5 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: 90°C/1.5 min contact hot plate
Develop: CD-26 Developer 2 x 60 sec puddles

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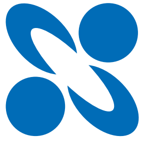
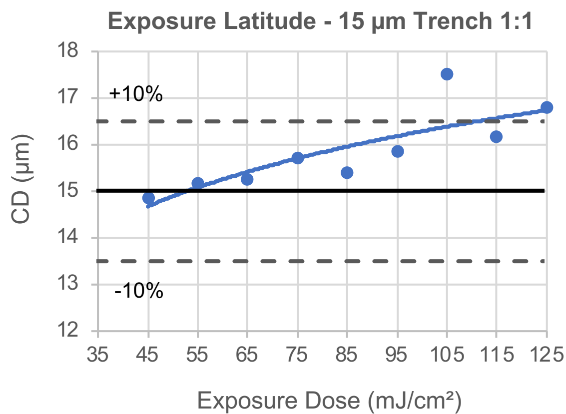
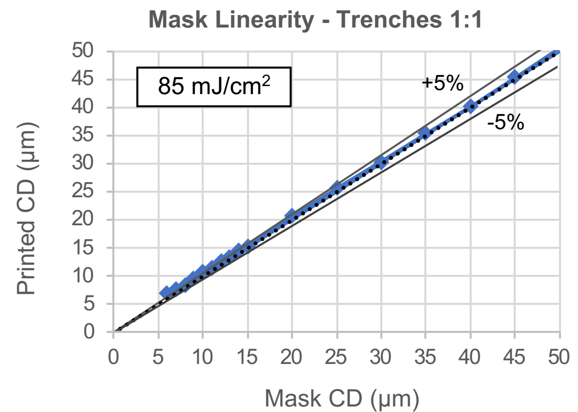


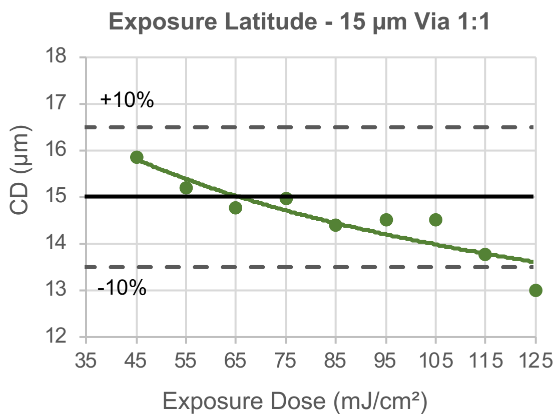
Processing Window

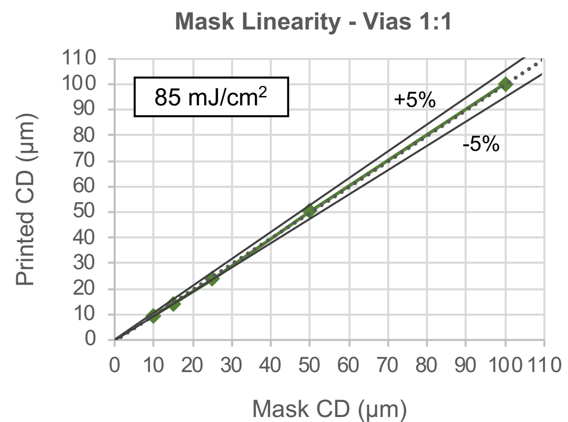
Processing window for exposure latitude and mask linearity on silicon.

Exposure (15 µm film thickness on Si)









Coated Thickness: 15 µm on Si wafer
Soft Bake: 115°C/3.5 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: 90°C/1.5 min contact hot plate
Develop: CD-26 Developer 2 x 60 sec puddles

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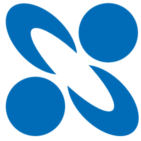

Post Exposure Bake (PEB)

A post exposure bake is necessary as it initiates the thermally-driven catalytic reaction to induce resist solubility. PEB should quickly follow exposure, no latency is required for hydration. Table 4 has the recommended PEB temperature and time for a 15 µm thick TempKoat™ N film. PEB optimization may be necessary for changes in film thickness and exposure dose.

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

SUBSTRATE	PEB TEMPERATURE ℃	PEB TIME minutes
Bare Si	85-90	1.5
PVD Cu on Si	85-90	1.5

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

Development

TempKoat™ N resist has been designed for use with 2.38% TMAH (0.26N) aqueous alkaline developer. Many alkaline based developers are compatible with TempKoat™ N, including surfactant and surfactant-free. See Table 5. Process optimization is necessary for different developer chemistries to achieve desired performance. Spray development is recommended with two 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

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

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

Removal

As TempKoat™ N 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) or DuPont's INTERVIA™ 2011 Remover (DMSO/ GBL). A 15 minute, agitated immersion is sufficient to completely remove TempKoat™ N. To prevent drying stains, 20 second IPA rinse and DI water rinse, followed by drying using filtered, pressurized air or nitrogen is recommended.

Commercial Availability

TempKoat™ N is not commercially available within the United States; however, small scale quantities may be purchased in the United States for R&D purposes.

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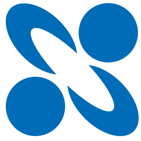

Storage

Store TempKoat™ N resist frozen in tightly closed, upright containers at 14°F (-10°C). Store away from light, acids, heat and sources of ignition. Shelf life is 13 months from date of manufacture for storage at 14°F (-10°C). Defrost TempKoat™ N at room temperature for 24 hours prior to use. Shelf life is shortened to 12 weeks if stored refrigerated (50°F/10°C), and 8 weeks if stored at room temperature (68-77°F/20-25°C) prior to use.

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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