

Technical datasheet AZ[®] nLOF[™] 2000 Series

Negative Tone Photoresists for Single Layer Lift-Off

APPLICATION

AZ® nLOF[™] 2000 Series i-line photoresists are engineered to simplify the historically complex image reversal and multi-layer lift-off lithography processes. Ideal lift-off pattern profiles are achieved using a standard expose/post expose bake/develop process flow. These photoresists are very fast and printed features are thermally stable to >200°C.

- TMAH developer compatible
- Single coat thicknesses from 2.0 to >10µm
- May be processed with vertical sidewalls for RIE etching

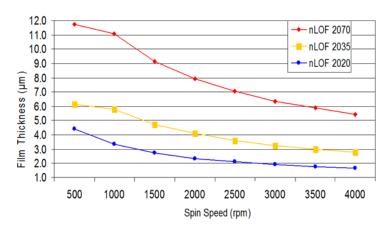
TYPICAL PROCESS

Soft Bake: 110°C/60-90s
Rehydration Hold: None
Expose: 365nm sensitive
Post Expose Bake: 110°C/60s

• Develop: Puddle, spray or immersion

• Developer Type: MIF
* PEB is required for proper imaging

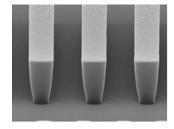
SPIN CURVES (150mm Silicon)

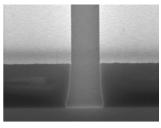




OPTICAL CONSTANTS*

Cauchy A	1.5946
Cauchy B (µm²)	0.01188
Cauchy C (μm ⁴)	0.00028
n @ 633nm	1.626
k @ 633nm	0





2.0µm lines and 2.0µm iso trench 3.5µm thick AZ® nLOF™ 2035 72mJ/cm² i-line Exposure AZ® 300 MIF Develop (120s)

COMPANION PRODUCTS

THINNING/EDGE BEAD REMOVAL

AZ EBR Solvent or AZ EBR 70/30

DEVELOPERS

AZ 300MIF, 726MIF, AZ 917MIF

REMOVERS

AZ 300T, AZ 400T



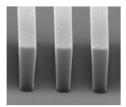
^{*} Unexposed photoresist film

EXAMPLE PROCESS (2.0µm Film Thickness on Si)

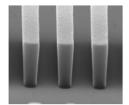
Process Step	Parameters
Prime	HMDS 140°C/60s (vapor)
Coat	2.0µm thick film AZ nLOF 2020 (33cPs) on bare Si
Soft Bake	110°C, 60 seconds, direct contact hotplate
Exposure	i-line @ 66mJ/cm² nominal (0.54NA) Nikon Stepper*
Post Expose Bake	110°C*, 60 seconds, direct contact hotplate
Develop	AZ 300MIF, 60s single puddle

^{*} Pattern profiles can be modified by varying exposure dose and PEB temperature. See profile optimization matrix for additional information.

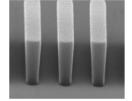
Resolution @ 66mJ/cm²



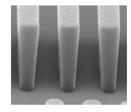
0.95µm



0.85µm

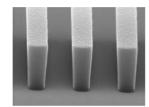


0.80µm

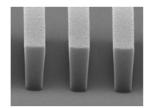


 $0.70 \mu m$

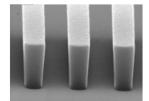
1.0µm Lines Through Dose



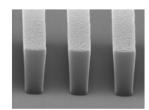
62mJ/cm²



66mJ/cm²

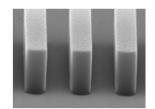


70mJ/cm²

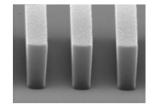


74mJ/cm²

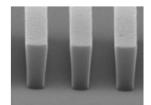
1.0µm Lines DoF @ 66mJ/cm²



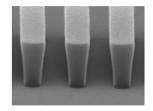
-0.2µm



0.2µm



0.6µm



1.0µm

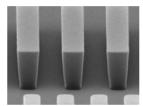


EXAMPLE PROCESS (3.5µm Film Thickness on Si)

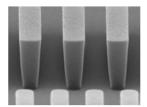
Process Step	Parameters
Prime	HMDS 140°C/60s (vapor)
Coat	3.5µm thick film AZ nLOF 2035 (79cPs) on bare Si
Soft Bake	110°C, 60s, direct contact hotplate
Post Bake Delay	None
Expose	i-line @ 80mJ/cm² nominal (0.548NA) Nikon Stepper*
Post Expose Bake	110°C*, 60 seconds, direct contact hotplate
Develop	AZ 300MIF, 120s single puddle

^{*} Pattern profiles can be modified by varying exposure dose and PEB temperature. See profile optimization matrix for additional information.

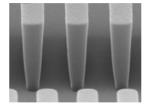
Resolution @ 80mJ/cm²



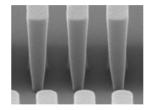
2.00µm



1.50µm

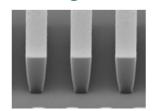


1.10µm

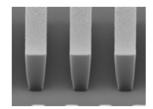


0.90µm

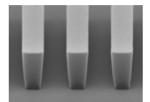
2.0µm Lines Through Dose



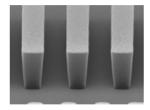
72mJ/cm²



80mJ/cm²

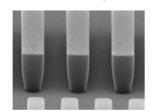


88mJ/cm²

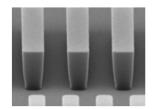


96mJ/cm²

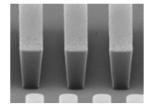
2.0µm Lines DoF @ 80mJ/cm²



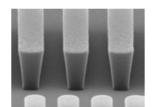
-1.0µm



0.0µm



1.0µm



1.8µm



EXAMPLE PROCESS (7.0µm Film Thickness on Si)

Process Step	Parameters
Prime	HMDS 140°C/60s (vapor)
Coat	7.0µm thick film AZ nLOF 2070 (330cPs) on bare Si
Soft Bake	110°C, 90s, direct contact hotplate
Post Bake Delay	None
Expose	i-line @ various doses (0.54NA) Nikon Stepper
Post Expose Bake	110°C, 90 seconds, direct contact hotplate
Develop	AZ 300MIF, 2 x 60 second puddles

BOTTOM CD vs. EXPOSURE DOSE (Mask CD = 7.0μ m dense lines)



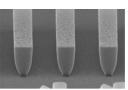
Dose: 174mJ/cm² Bottom CD: 4.45µm Dose: 186mJ/cm² Bottom CD: 4.84µm Dose: 198mJ/cm² Bottom CD: 5.31µm

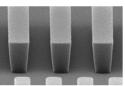
EXAMPLE PEB SENSITIVITY (3.5µm Film Thickness on Si)

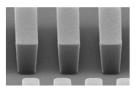
PEB **105°C**/60sec Top size: 1.734 Bottom: 0.726µm

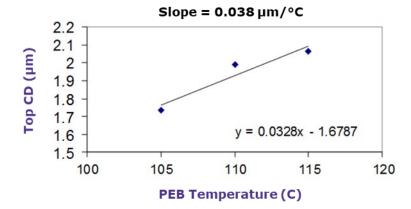
PEB **110°**C / 60sec Top: 1.992 μm Bottom: 1.439μm

PEB **115°**C / 60sec Top: 2.062 μm Bottom: 1.687μm







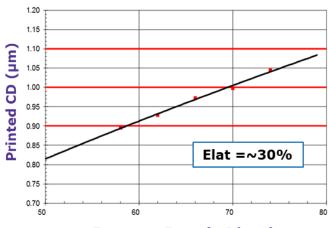




SAMPLE PROCESS WINDOWS on Si (FT 2.0µm and 3.5µm)

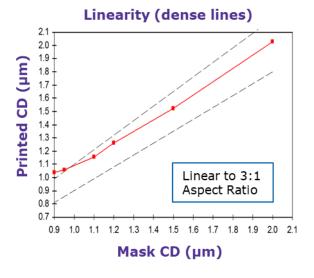
Linearity (dense lines) 2.0 1.9 1.8 1.7 Printed CD (µm) 1.6 1.5 1.4 1.3 1.2 1.1 1.0 Linear to 3:1 0.9 Aspect Ratio 0.8 0.7 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 Mask CD (µm)

Exposure Latitude (1.0µm dense lines)

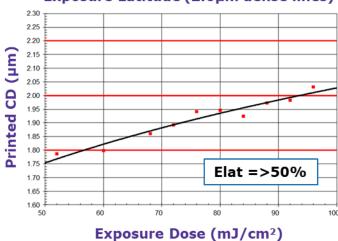


Exposure Dose (mJ/cm²)

Coat: AZ® nLOF™ 2020 @ FT=2.0µm Soft Bake: 110C/60s Expose: Nikon Stepper @ 0.54NA Post Expose Bake: 110C/60s Develop: AZ® 300MIF 60s puddle



Exposure Latitude (2.0µm dense lines)



Coat: AZ® nLOF™ 2020 @ FT=3.5µm Soft Bake: 110C/60s Expose: Nikon Stepper @ 0.54NA Post Expose Bake: 110C/60s Develop: AZ® 300MIF 120s puddle



EXAMPLE PROFILE Tuning by Varying PEB and Exposure Dose

Process Step	Parameters
Prime	HMDS 140°C/60s (vapor)
Coat	2.0µm thick film AZ nLOF 2020 (33cPs) on bare Si
Soft Bake	110°C, 60 seconds, direct contact hotplate
Exposure	i-line @ varying dose (0.54NA) Nikon Stepper
Post Expose Bake	Various as indicated
Develop	AZ 300MIF, 60s single puddle

Profile Response to Varying Dose and PEB Temperature



PROCESS CONSIDERATIONS

SUBSTRATE PREPARATION

Substrates must be clean, dry, and free of organic residues. Oxide forming substrates (Si, etc.) should be HMDS primed prior to coating AZ nLOF™ 2000. Contact your product representative for detailed information on pre-treating with HMDS.

SOFT BAKE

Soft bake times and temperatures may be application specific. Process optimization is recommended to ensure optimum pattern profiles and stable lithographic and adhesion performance. Soft bake temperatures for AZ $nLOF^{TM}$ 2000 should be in the $100^{\circ}-110^{\circ}C$ range. Delays between soft bake and exposure should be minimized for optimum performance.

EXPOSURE

AZ nLOF 2000 requires exposure energy at the 365nm wavelength.

POST EXPOSE BAKE

A PEB <u>is required</u> for proper imaging of AZ nLOF[™] 2000. PEB temperatures and times may be application specific. As a general rule, PEB temperatures should be in the 100° to 115°C range. As with any chemically amplified photoresist, CD's in nLOF[™] 2000 will exhibit some dependency on PEB temperature (< 0.04µm/°C is typical).

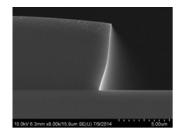
DEVELOPING

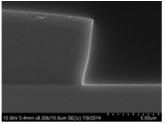
AZ nLOF™ 2000 series photoresists are compatible with industry standard 0.26N (2.38%) TMAH developers. AZ 300MIF is recommended.

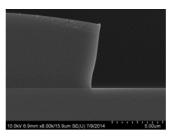
HARD BAKE

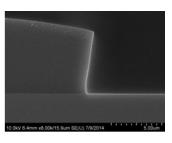
Hard baking (post develop bake) improves adhesion in wet etch or plating applications and improves pattern stability in dry etch or deposition chambers. AZ $nLOF^{TM}$ materials are extremely thermally stable and may be hard baked at temperatures above 150°C.

HARD BAKE STABILITY for Large Pads in AZ nLOF™ 2070 (7.0µm Film Thickness)









115C Hard Bake

120C Hard Bake

125C Hard Bake

130C Hard Bake



STRIPPING

AZ nLOF™ 2000 Series resists are compatible with industry standard solvent based removers. AZ 400T or AZ Remover 770 is recommended.

COMPATIBLE MATERIALS

AZ nLOF[™] 2000 Series materials are compatible with all commercially available lithography processing equipment. Compatible materials of construction include glass, quartz, PTFE, PFA, stainless steel, HDPE, polypropylene, and ceramic. AZ nLOF[™] 2000 series photoresists are not recommended for use on copper substrates.

HANDLING/DISPOSAL

AZ nLOF™ 2000 Series materials contain PGMEA (1-Methoxy-2-propanol acetate). Refer to the current version of the MSDS and to local regulations for up to date information on safe handling and proper disposal. Wear solvent resistant gloves, protective clothing, and eye/face protection.

AZ nLOF™ 2000 is compatible with drain lines handling similar organic solvent based materials.

www.merckgroup.com

Disclaimer

Products are warranted to meet the specifications set forth on their label/packaging and/or certificate of analysis at the time of shipment or for the expressly stated duration. MERCK MAKES NO REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE REGARDING OUR PRODUCTS OR ANY INFORMATION PROVIDED IN CONNECTION THEREWITH. Customer is responsible for and must independently determine suitability of Merck's products for customer's products, intended use and processes, including the non-infringement of any third parties' intellectual property rights. Merck shall not in any event be liable for incidental, consequential, indirect, exemplary or special damages of any kind resulting from any use or failure of the products: All sales are subject to Merck's complete Terms and Conditions of Sale. Prices are subject to change without notice. Merck reserves the right to discontinue products without prior notice.

The information on our trademarks is available in the Trademarks section on www.merckgroup.com. Detailed information on our trademarks is also available via publicly accessible resources. All other trademarks are the property of their respective owners.

© 2021 Merck KGaA, Darmstadt, Germany and/or its affiliates.

