HARP™ PMMA and HARP-C™ Copolymer

High Aspect Ratio PMMA and Copolymer for e-Beam Lithography

HARP™ & HARP-C™ RESIST SERIES

1000 HARP eB
- Highest Mw (molecular weight) PMMA polymer
- Manufactured in Anisole
- Best resolution & contrast PMMA
- Competes with 950 PMMA

500 HARP eB
- PMMA Polymer with mid-range Mw
- Faster throughput versus 1000 HARP eB
- Manufactured in Anisole
- Competes with 495 PMMA

HARP-C
- MMA/MAA *(methyl methacrylate/methacrylic acid)* copolymer
- Manufactured in Ethyl Lactate
- Used in multi-layer process with PMMA
- Competes with MMA(8.5)MAA

DESCRIPTION

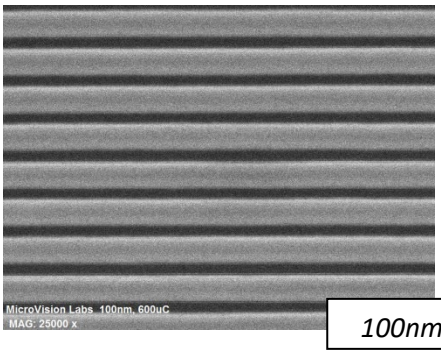
HARP PMMA (polymethyl methacrylate) resist is designed for high resolution direct write e-Beam lithography. When combined with HARP-C copolymer the HARP multi-layer system is ideal for T-gate manufacture. HARP PMMA has excellent adhesion to a wide variety of substrates, and is used as a protective coating layer for wafer thinning and sacrificial layers.

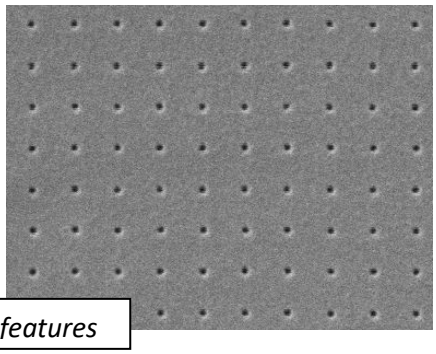
APPLICATIONS

- e-beam direct write lithography
- Multi-layer T-gate manufacture
- X-Ray LIGA
- Protective Coating for wafer thinning

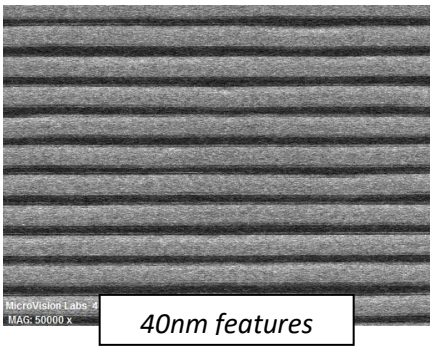
SAFE SOLVENT

HARP PMMA products are manufactured in safe solvents (anisole and ethyl lactate).





100nm features



40nm features

SUBSTRATE

HARP PMMA adheres to a variety of substrates including; silicon, gold, aluminum, chromium and copper. Proper substrate cleaning (with O2 plasma) and dehydration bakes can improve adhesion.

SPIN COAT

Film thickness is targeted using the spin speed curves on the following page. Coat program includes a 5-10 second spread cycle. Spin time at final speed is 45 seconds. Spin curves are determined using 6 inch Si and static dispense of approximately 3ml of photoresist.

SOFT BAKE

Recommended soft-bake on contact hotplate:

HARP PMMA
180 °C for 2 min.

HARP-C Copolymer
150 °C for 90 sec.

EXPOSURE (SEE DOSING MATRIX)

e-Beam: 100 – 1000 μC/cm^2

Energy: 20 – 100 kV source

Example exposure: 1000 HARP at 0.2 – 0.5 μm film thickness

600 μC/cm^2 using 50kV energy source to obtain 40 nm feature size

DEVELOP

HARP PMMA and Copolymer Series Resists are developed with MIBK / IPA Developer using immersion, puddle, and spray techniques.

Example process (immersion)

1. 60 second immersion in MIBK/IPA
2. 30 second rinse with IPA
3. Spin dry or N2 blow dry

HARP PMMA Developers	
MIBK/IPA 1:1	High resolution and fast develop
MIBK/IPA 1:3	Highest resolution and slow develop

RINSE & DRY

Rinse: IPA (Isopropyl alcohol) or DI water to end the development process.

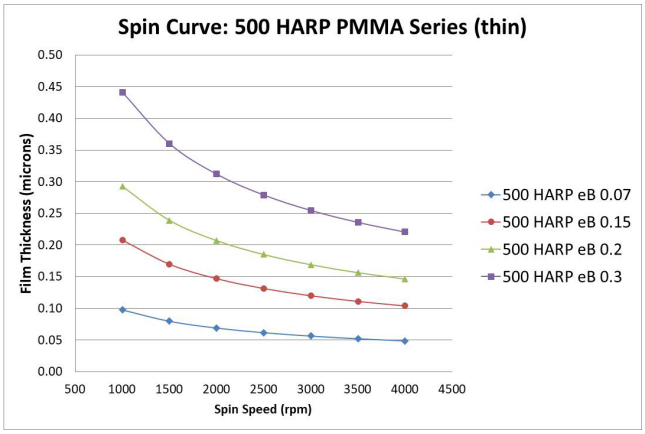
Dry: Blow dry with N2 or bake at 100oC for 60 seconds to remove residual developer & rinse materials.

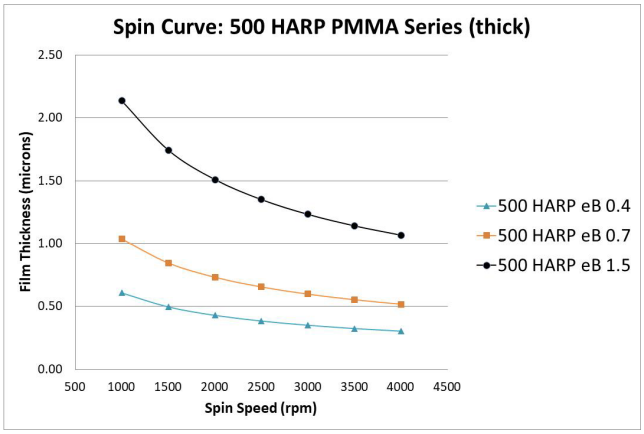
REMOVAL

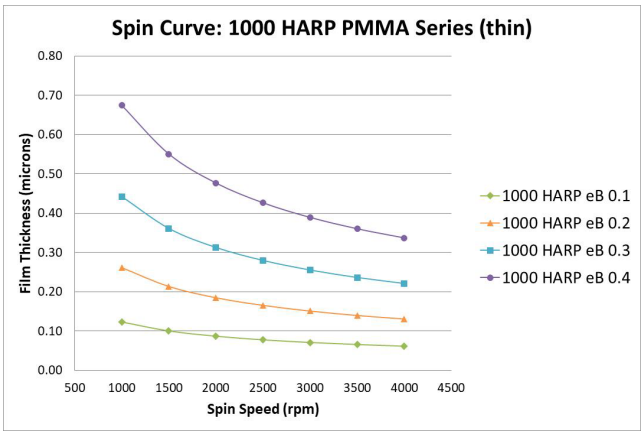
Removal is performed using industry standard removers:

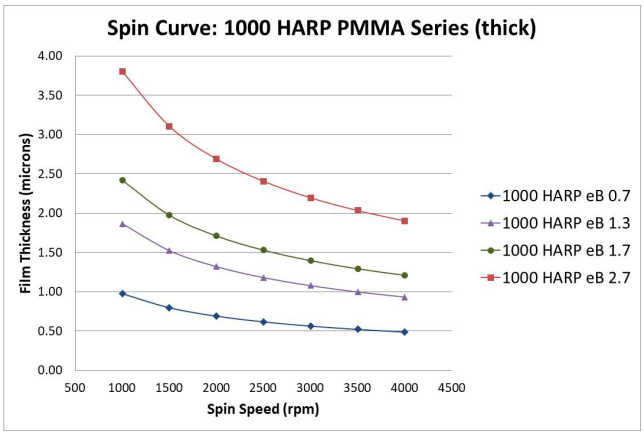
- Acetone & other cleanroom solvents
- NMP-based (n-methyl-2-pyrrolidone)
- O2 plasma
- Glacial acetic acid

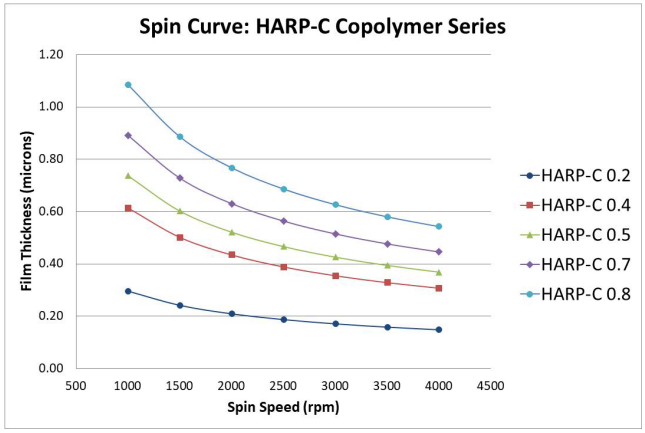
SPIN SPEED CURVES FOR HARP PMMA AND COPOLYMER RESISTS











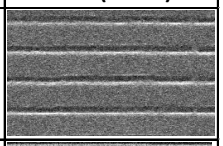
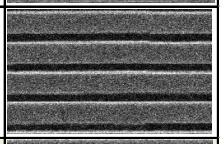
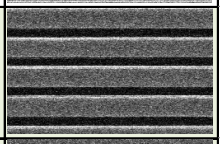
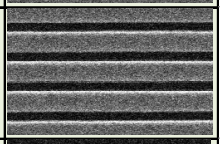
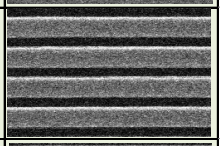
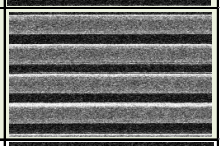
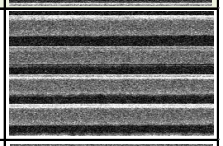
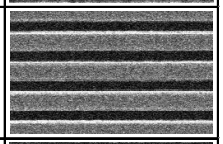
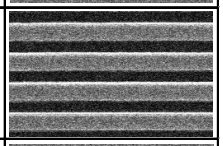
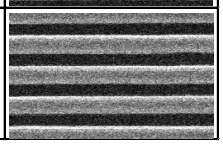
FILM THICKNESS @ 2000 RPM AND VISCOSITY FOR HARP PMMA AND COPOLYMER RESISTS

Product	Approximate FT (microns) at 2000 rpm	Approximate Viscosity (cst)	Competitive Product
1000 HARP eB 0.1	0.1	8	950 PMMA A2
1000 HARP eB 0.2	0.2	15	950 PMMA A3
1000 HARP eB 0.3	0.3	27	950 PMMA A4
1000 HARP eB 0.4	0.4	47	950 PMMA A5
1000 HARP eB 0.7	0.7	75	950 PMMA A6
1000 HARP eB 1.3	1.3	191	950 PMMA A8
1000 HARP eB 1.7	1.7	282	950 PMMA A9
1000 HARP eB 2.7	2.7	620	950 PMMA A11
500 HARP eB 0.07	0.07	5	495 PMMA A2
500 HARP eB 0.15	0.15	9	495 PMMA A3
500 HARP eB 0.2	0.2	14	495 PMMA A4
500 HARP eB 0.3	0.3	21	495 PMMA A5
500 HARP eB 0.4	0.4	32	495 PMMA A6
500 HARP eB 0.7	0.7	63	495 PMMA A8
500 HARP eB 1.5	1.5	169	495 PMMA A11
HARP-C 0.2	0.2	9	8.5 MAA EL 6
HARP-C 0.4	0.4	18	8.5 MAA EL 9
HARP-C 0.5	0.5	22	8.5 MAA EL 10
HARP-C 0.7	0.7	30	8.5 MAA EL 11
HARP-C 0.8	0.8	39	8.5 MAA EL 12

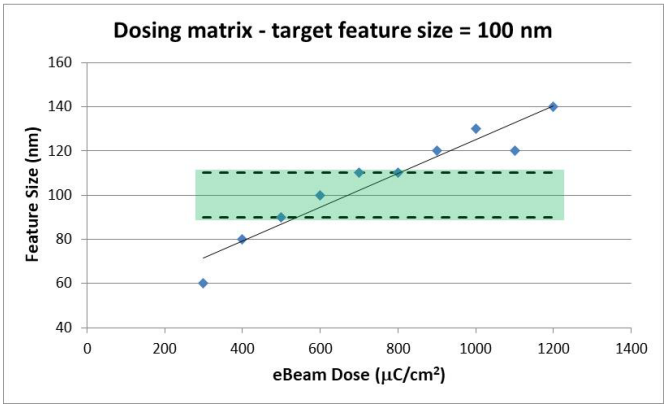
KemLab PHOTORESIST MANUFACTURING & INNOVATION

HARP PMMA and Copolymer Series Resists

DOSING MATRIX

Target 100 nm		
Dose (µC/cm²)	Feature Size (nm)	SEM (1000x)
300	60	
400	80	
500	90	
600	**100**	
700	110	
800	110	
900	120	
1000	130	
1100	120	
1200	140	

Process	
Product:	1000 HARP eB 0.3
Tool:	Raith EBPG5000
Film Thickness:	0.3 microns
Accelerating Voltage:	50 kV
Develop:	60 sec immersion in MIBK/IPA 1:3
Rinse:	IPA
Optimal Dose:	**600 µC/cm²**
Dose Range (+/-10%)	**500 µC/cm² - 800 µC/cm²**



PROCESSING ENIVIRONMENT

For best results, use HARP PMMA and Copolymer Series Resists in a controlled room temperature environment of 68 – 77°F (20-25°C) is recommended.

STORAGE

Avoid light and store in an upright airtight container at room temperature. Do not refrigerate. Keep resist away from oxidizers, acids, bases and sources or ignition. Shelf life is 18 months from date of manufacture.

HANDLING & DISPOSAL CONSIDERATIONS

Consult the SDS for handling and appropriate PPE. HARP PMMA contains a combustible liquid; keep away from ignition sources, heat, sparks and flames. HARP PMMA materials are compatible with typical waste streams used with photoresist processing. It is the user's responsibility to dispose in accordance with all local, state, and federal regulations.

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