DisChem
CHEMISTRY FOR
ADVANCED LITHOGRAPHY

SURPASS

MICROLITHOGRAPHY ADHESION PROMOTER / PRIMING AGENT

Document ID: SPXT2010

SurPass is a waterborne cationic organic surface-active agent designed to promote adhesion and improve overall coating quality of micro / nano lithographic resists on a broad range of substrate materials. SurPass promotes microlithographic resist adhesion through cationic interaction and modification of the substrate surface energy.

Advantages in Advanced Lithographic Processing:

- *Improved microlithographic resist adhesion on a broad range of substrate materials.*
- *Improved adhesion at low doses in electron beam lithography*
- *Improved removal of critical substrate contaminants*
- *Reduced z-potential for improved resist coating properties*
- *Improved patterned resist mold to copper seed layer for subsequent electroforming.*
- *Increased adhesion of evaporated metals to substrate materials*
- *Non-Hazardous waterborne formulation / No hazardous breakdown products*

Functional Description

SurPass contains a cationic polymer with an anionic counter ion. The counter ion is discharged upon contact with the substrate, modifying the available surface energy to make it more compatible with solvent based resists. The change in surface energy is achieved without depositing a film or chemically altering the substrate material.

In addition to promoting adhesion, SurPass reduces the zeta potential to provide a more uniform coating surface for improved resist flow. Evidence suggests that SurPass may be used to improve performance and reduce material consumption. SurPass provides improved coating flow and uniformity even where resist adhesion is not an issue.

Substrate / Resist compatibility

SurPass demonstrates excellent adhesion properties on a wide range of III-V semiconductor materials, metals, metal oxides, ceramics (ruby, sapphire) and plastics (PET).

SurPass has shown compatibility with most positive and negative resist and polymer formulations, providing excellent adhesion when used in conjunction with phenolic resin novolac resist, DNQ, PMMA, PMGI, epoxy based polymer (SU8), polyimide, electron beam resist (including HSQ), chemically and non-chemically amplified photoresist.

SurPass Formulations and Properties

SurPass is manufactured in two versions designated as SurPass 3000 (P/N SP3) and SurPass 4000. (SP4) Both variants of SurPass are waterborne, non-hazardous, and produce no ammonia or other breakdown products during application.

> **SurPass 3000:** Waterborne, mildly acidic (pH 3.0-3.5) and contains a cleaning and surfactant package for removal of critical contaminants while optimizing surface energy

for improved resist adhesion. May be used as an ultrasonic cleaning solution for combined final cleaning and promoting adhesion. Utilizes a Cl^- counter ion. Water rinse after application may be followed by IPA rinse to minimize dry time.

SurPass 4000: Waterborne, slightly alkaline (pH 9.5-10.0) and contains no additives. Broad range substrate - resist compatibility. Utilizes an OH^- counter ion. Rinse with water or IPA. Excellent for improving adhesion of patterned resist mold on copper seed layer for subsequent electroplating. SurPass 4000 can also be used to eliminate the need for a metallic barrier layer when evaporating gold onto glass.

Selection of Appropriate SurPass Primer:

SurPass 3000 and 4000 are generally interchangeable for most substrate materials. Effectiveness can be quantitatively evaluated by measuring the change in contact angle toward greater hydrophobicity, with higher hydrophobicity suggesting increased efficacy for the version of SurPass to the substrate material.

Use and Application

SurPass may be applied by spin coating, dip / immersion, spray, etc. or any other means that allows for coat - rinse - dry cycle, followed by application of the resist. SurPass 3000 allows for bulk processing and can be used with ultrasonic agitation to combine final cleaning with adhesion priming.

Spin Coat Application:
1. Clean substrate, normal cycle.
2. Spin coat SurPass at 3000 rpm / 30 seconds
3. DI water[1] rinse substrates for 30-60 seconds.
4. Dry[2] by spin or nitrogen blow.
5. Optional dehydration bake[3].
6. Process with resist per protocol.

Immersion / Ultrasonic / Batch Processing:
1. Clean substrate, normal cycle. Separate wet chemical cleaning can be eliminated when using SurPass 3000 with ultrasonic agitation.
2. Immerse substrates in SurPass bath for 30-60 seconds.
3. DI water[1] rinse substrates for 30-60 seconds.
4. Dry[2] by spin or nitrogen blow.
5. Optional dehydration bake[3].
6. Process with resist per protocol.

Equipment Requirements:

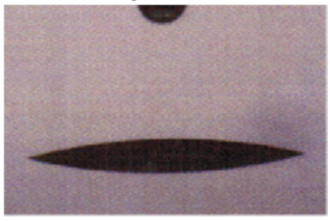
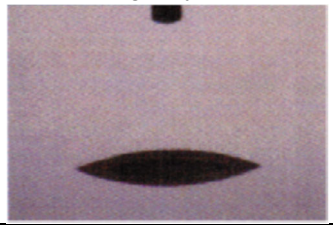
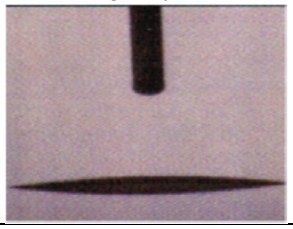
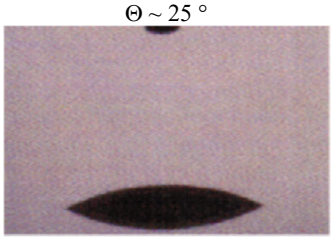
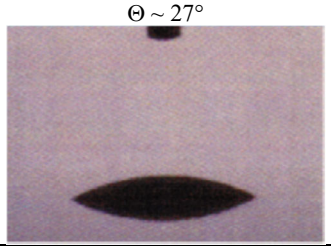
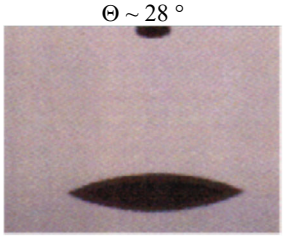
Equipment:	PE, HDPE, PTFE or Nylon is recommended.
Filtration:	SurPass is provided prefiltered to 0.2 µm. No additional filtration is required.

[1] SurPass 4000 make be rinsed with water or IPA.
[2] Drying time may be reduced by rinsing with isopropyl alcohol after the water rinse.
[3] Dehydrate bake in normally not required for silicone and silicone nitride substrates. A dehydration bake of up to 180°C / 5 minutes may improve adhesion to metals and metal alloys

Background and Performance Data

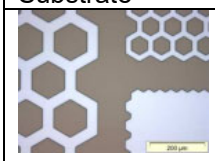
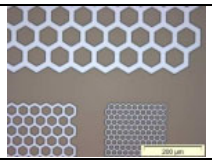
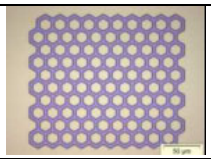
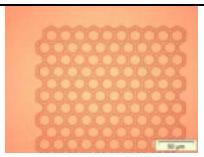
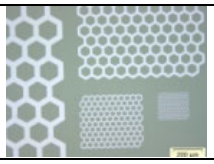
Surface Energy

The effect of SurPass on substrate surface energy is demonstrated by measuring contact angle on treated and untreated Si wafers.

Si - Untreated Θ ~ 14 ° 	Si + 0_2 Plasma Θ ~ 20 ° 	Si + 0_2 Plasma + Dehydration Bake Θ ~ 10 ° 
Si + SurPass 3000 + Water Rinse Θ ~ 25 ° 	Si + SurPass 4000 + Water Rinse Θ ~ 27° 	Si + SurPass 4000 + IPA Rinse Θ ~ 28 ° 

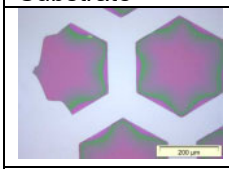
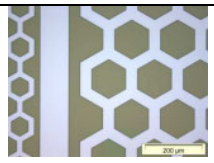
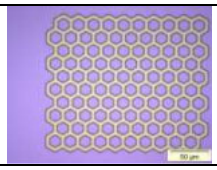
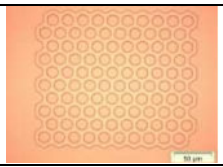
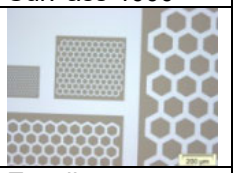
Positive Tone DNQ / Novolac Resist (ma-P1200 series)

ma-P 1200, Film thickness = 7.5 µm, development in 0.22 to 0.26N TMAH
Images provide courtesy of *micro resist technology* GmbH, Berlin, Germany

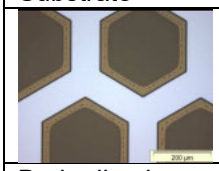
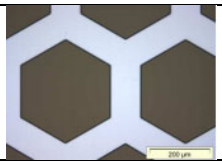
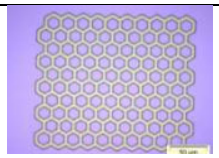
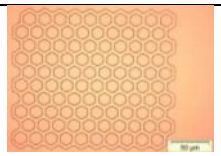
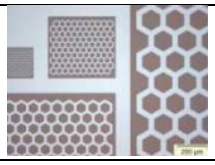
Control, Silicon Substrate	Si + SurPass 4000	SiO_2 + SurPass 4000	Glass + SurPass 40000	GaP + SurPass 4000	Cu + SurPass 4000
					
Bad adhesion of small patterns	Excellent adhesion	Excellent adhesion	Excellent adhesion	Excellent adhesion	Excellent adhesion

Negative Tone Aromatic Bisazide / Novolac Resist (ma-N 400, ma-N 1400 series)

ma-N 1400, Film thickness 1 µm, developed in ma-D533/S or 0.363 N TMAH

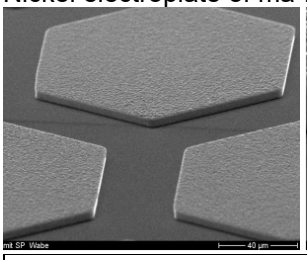
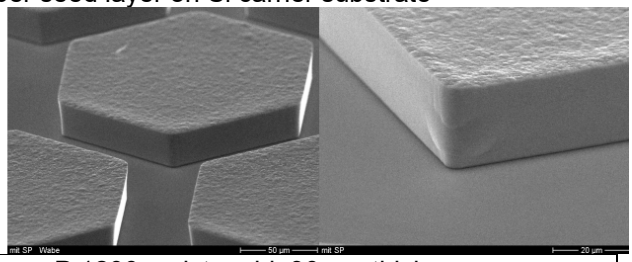
Control, Silicon Substrate	Si + SurPass 4000	SiO_2 + SurPass 4000	Glass + SurPass 40000	GaP + SurPass 4000
				
Bad adhesion	Excellent adhesion	Excellent adhesion	Excellent adhesion	Excellent adhesion

ma-N 400, Film thickness = 7.5 µm, developed in ma-D 332S or 0.2N NaOH or 0.275N TMAH

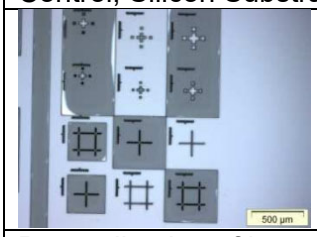
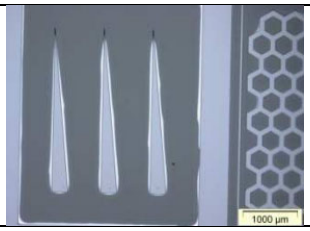
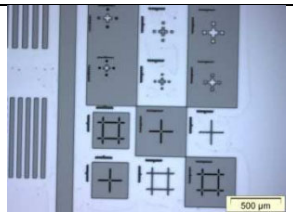
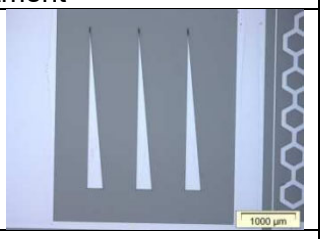
Control, Silicon Substrate	Si + SurPass 4000	SiO_2 + SurPass 4000	Glass + SurPass 40000	GaP + SurPass 4000
				
Bad adhesion	Excellent adhesion	Excellent adhesion	Excellent adhesion	Excellent adhesion

Nickel Electroplate on Positive Tone DNQ / Novolac Resist (ma-P1200 series)

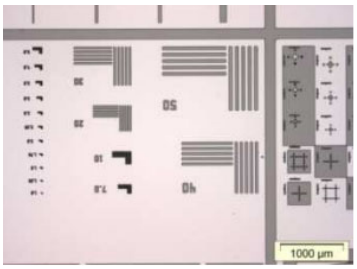
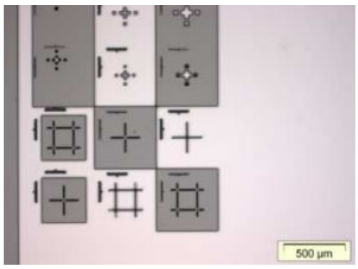
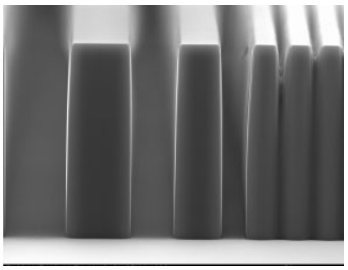
Nickel electroplate of ma-P 1200 resist mould on copper seed layer on Si carrier substrate

	
ma-P 1200 resist mold, 7.5 µm thick. Ni electroplated to 5 µm thickness on Cu seed layer	ma-P 1200 resist mold, 30 µm thick. Ni electroplated to 25 µm thickness on Cu seed layer

SU-8 Epoxy Resist Adhesion on Various Substrate Materials

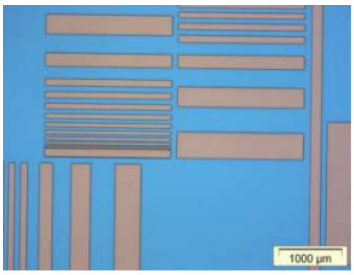
Control, Silicon Substrate		Si+ SurPass 3000 treatment	
			
Poor adhesion of large patterns		Excellent Adhesion	

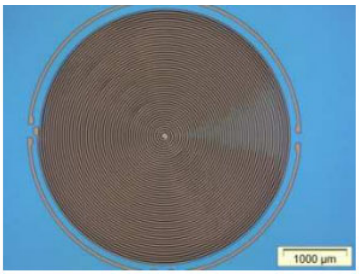
SU-8 on silicone substrate

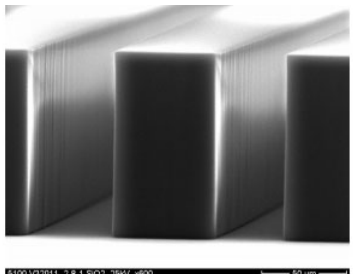




SU-8 epoxy resist on Si substrate treated with SurPass 3000

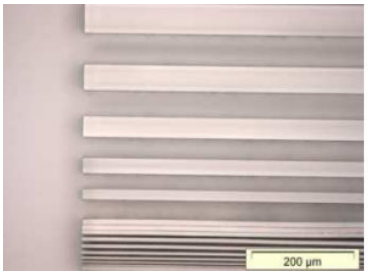
SU-8 adhesion on various substrate materials, continued

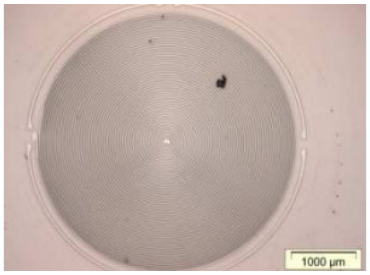


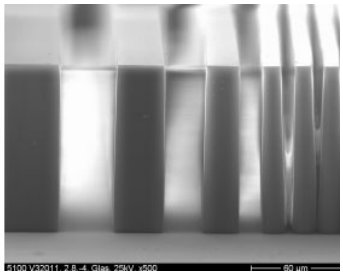




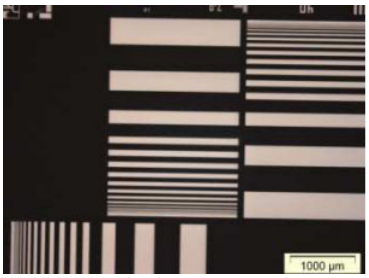
SU-8 epoxy resist on SiO_2 substrate treated with SurPass 3000

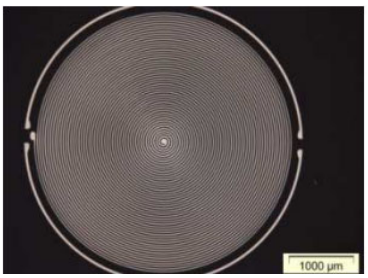


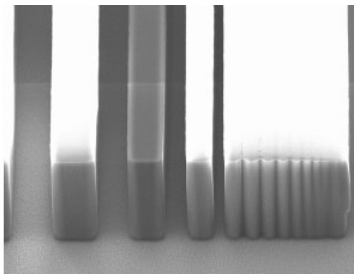




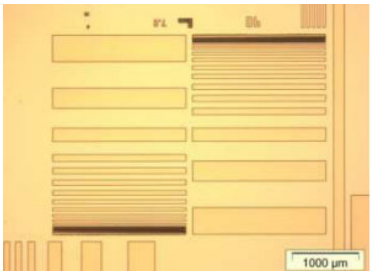
SU-8 epoxy resist on Glass substrate treated with SurPass 3000

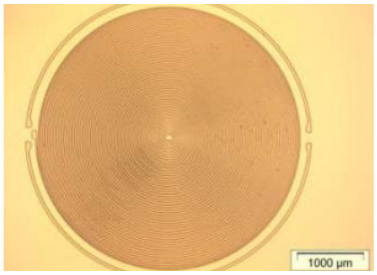


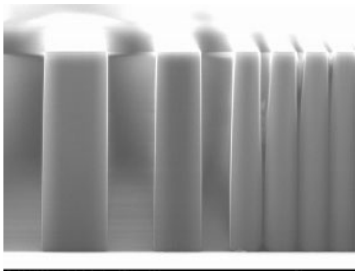




SU-8 epoxy resist on TiO_x substrate treated with SurPass 3000







SU-8 epoxy resist on Cr/Au on Si substrate treated with SurPass 3000

Improved Adhesion of HSQ Electron Beam Resist

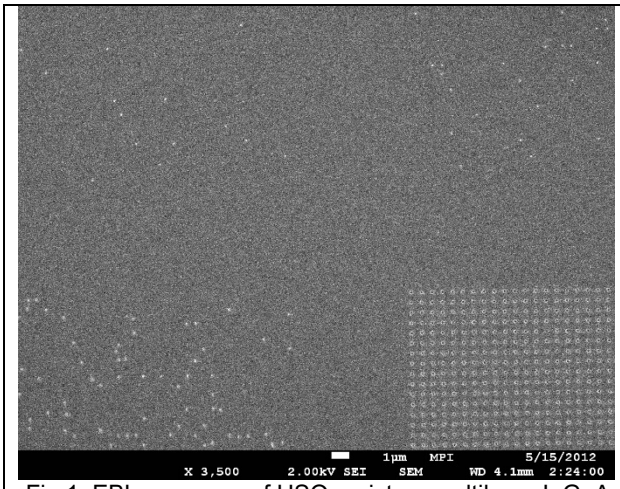


Fig 1: EBL exposure of HSQ resist on multilayer InGaAs **No Treatment** prior to application of resist

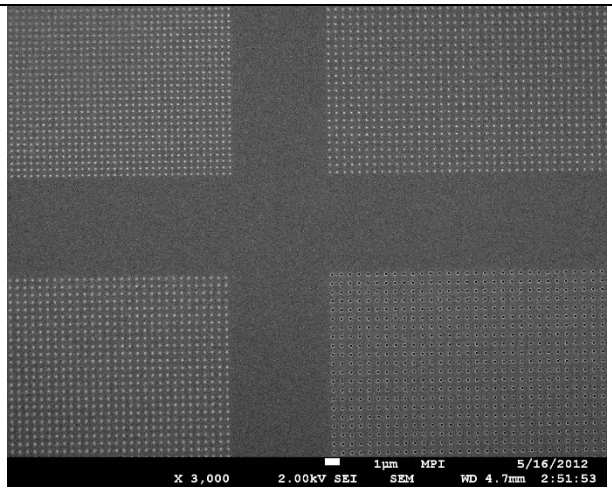


Fig 2: EBL exposure of HSQ resist on multilayer InGaAs **Treated with SurPass 3000** prior to application of HSQ resist

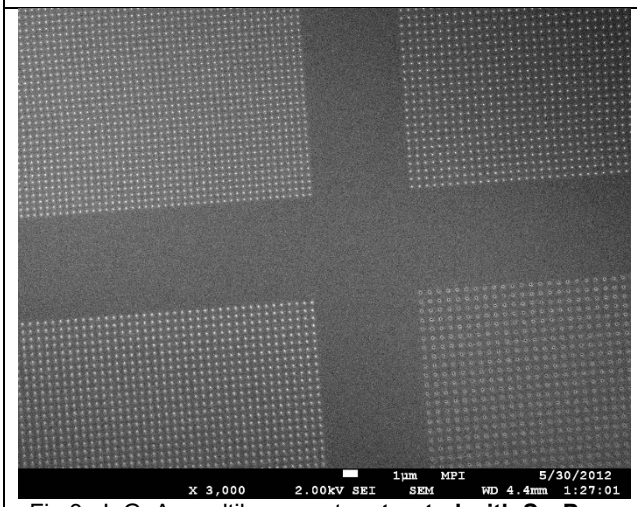


Fig 3: InGaAs multilayer system **treated with SurPass 3000 prior** to application HSQ resist. **Exposure dose reduced by factor of four**

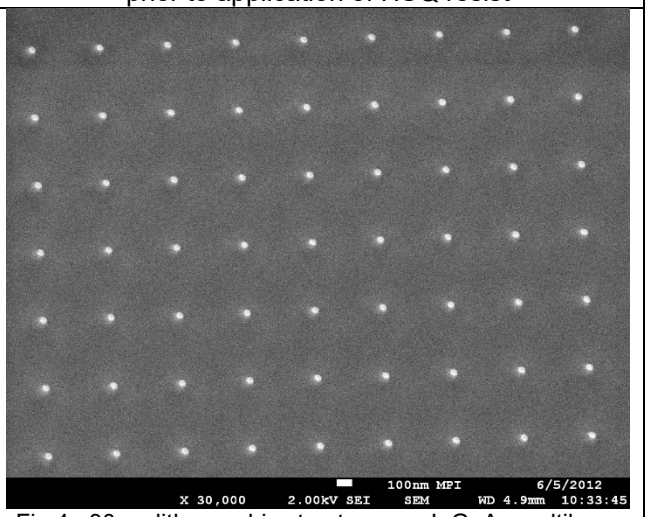


Fig 4 : 30nm lithographic structures on InGaAs multilayer system **treated with SurPass 3000** prior to application of HSQ. **Exposure dose reduced by factor of four.**

An array consisting of four quadrants of 30nm, 50nm 100nm and 200nm were created with HSQ on a multilayer InGaAs on GaAs system were created using electron beam lithography. This mask created in HSQ resist was transferred by RIE (Reactive Ion Etching) into the substrate. Wafers treated with SurPass 3000 demonstrated a dramatic improvement in adhesion of the resist to the wafer, while allowing the electron beam dose to be reduced by a factor of four.

Additional Uses and Applications for SurPass

Prevents Delamination of Gold on Native Silicone Oxide

SurPass 4000 can be used to allow for direct deposition of gold on native silicone oxide without the need for a metallic seed / barrier layer.

Electropolish Pre-Step

SurPass 4000 has been shown to greatly improve uniformity in electropolishing of stainless steel when used as a pre-step after solvent cleaning.

Acrylic Molding Pre-Step

SurPass 3000 may be used prepare stainless steel for molding / embedding in acrylic. Pre-treatment with SurPass increases acrylic adhesion to stainless steel while preventing air bubble formation.

Product Availability and Ordering Information

SurPass is provided ready to use and pre-filtered to 0.20 microns. Product concentrates are also available for high volume applications.

Product Inquiries & Ordering Information:

DisChem, Inc.
17295 Boot Jack Rd, Suite A
Ridgway, PA 15853
USA

Telephone: (814) 772 - 6603
Fax: (814) 772 – 0946
E-mail: info@dischemінc.com
Web Site: www.dischemінc.com

Product Codes / Description:

SP31L- SurPass 3000, 1 liter bottle
SP301- SurPass 3000, 1 gallon (3.8L) bottle
SP304 - SurPass 3000, case of 4 X 1 gallon bottles
SP3DX - SurPass 3000DX Concentrate (10X), 1 gallon bottle

SP41L- SurPass 4000, I liter bottle
SP401- SurPass 4000, 1 gallon bottle
SP404 - SurPass 4000, case of 4 X 1 gallon bottles
SP4DX - SurPass 4000DX Concentrate (10X), 1 gallon bottle

Note: 1 gallon = 3.785 Liters

This product is protected by US and international patents

DisChem
CHEMISTRY FOR ADVANCED LITHOGRAPHY

DisChem Mission Statement

DisChem is dedicated to serving the needs of the Advanced Lithography community by providing innovative chemical solutions.

Document ID: SPXT2010
Revision Date: October 2020