

Huntsman is one of the world's largest producers of amine chemistries. Our E-GRADE® products can be used in formulation of process materials for Semiconductor, Display and other electronics. This broad product portfolio gives flexibility in expanding the options for many applications and includes our high purity aprotic solvents in ULTRAPURE™ grades for lithium-ion batteries and low trace metal E-GRADE® quality for microelectronic applications.

PRODUCT OVERVIEW




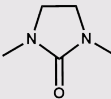
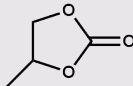
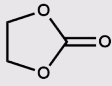
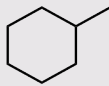
ULTRAPURE™ Carbonates, EC and PC, are extremely high purity solvents formulated for use in lithium-ion batteries, electrochromic glass, polymer removal, and other microelectronic cleaning applications. **E-GRADE® PC** is also available for formulated semiconductor cleans.

E-GRADE® MEOX and **E-GRADE® DMEU** are polar aprotic solvents well suited for use in a wide range of applications due to their excellent solvency, relatively high flash points, low vapor pressure, and ease of handling. Both products are soluble in most organic solvents and water. Typical applications include photoresist stripper and cleaning in the production of semiconductors. These solvents can also be used as replacements for NMP and DMSO.

BENEFITS

- Low odor
- Aprotic
- Low evaporation rate
- Less hygroscopic
- High flash point
- Low trace metals
- Water soluble and easily rinseable
- Alternative to NMP and DMSO

TYPICAL PROPERTIES

	NMP (reference)	DMSO (reference)	MEOX	DMEU	Propylene Carbonate	Ethylene Carbonate	MCH
Structure							
Molecular Weight	99	78	101	114	102	88	98
Viscosity (cP@25°C)	1.7	1.1	3.0	2.0	2.5	1.5 (40°C)	0.7 (20°C)
Flash Point (°C, cc)	86	89	113	95	135	152	-4
BP (°C)	202	189	259	225	242	248	101
MP (°C)	-25	19	15	8	-49	36	-127
Contact Angles on Al (100 wt%)*	54.1	62.4	62.5	-	-	-	-
VOC (ppm)**	1558	302	19	130	3	4 (50°C)	1940
Dipole Moment	4.09	3.96	4.13	4.07	4.98	4.90	0.00
Solubility Parameter							
dD	18.0	18.4	18.1	18.0	20.0	18.0	16.0
dP	12.3	16.4	10.9	10.5	18.0	21.7	0.0
dH	7.2	10.2	11.8	9.7	4.1	5.1	1.0

* Contact angle measurements were collected with neat NMP and MEOX on aluminum substrate using Dataphysics OCA 25 Instrument.

** VOC measurements were recorded with Honeywell MiniRAE 3000+ Photoionization Device at room temperature, 25% humidity.



E-GRADE®

AMINES

PRODUCT GRADES

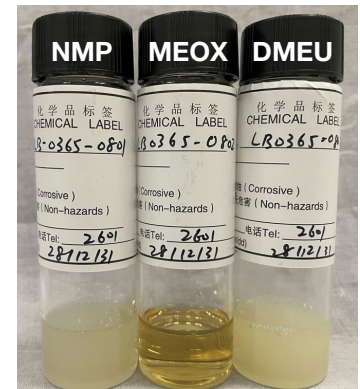
Grades	SEMI Standard	Typical PPB
E-GRADE®	VLSI	<20
E-GRADE® ULM	Grade 2	<10
E-GRADE® SLM	Grade 3	<2

Solvent Only for AZ1500 Positive Photoresist Stripping

Stripping condition 50°C, 5 min	Initial PR pattern	Hard bake (120 - 180°C, 2 min) Full strip	Hard bake (>185°C, 2 min) Partial strip
NMP		Clear	
DMEU		Clear	
MEOX		Clear	

Positive Novolak photoresist patterned on 4 inch bare wafer followed by hard baking patterned wafer at 120 - 200°C for 2 min. The wafer was then stripped in solvent at 50°C for 5 min, and the photoresist pattern checked by microscope.

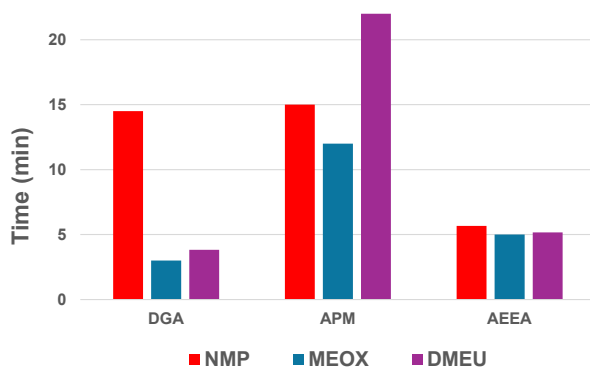
Solvency Test



Novolak resin solution in NMP, MEOX and DMEU.

E-GRADE® MEOX demonstrated better solvency relative to NMP.

Solvent and Amine Blends for AZ1500 Positive Photoresist Stripping



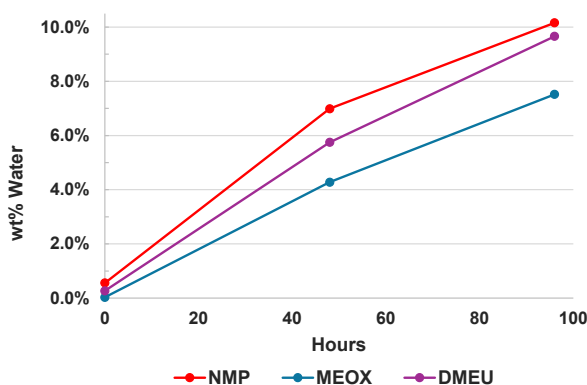
AZ1500 was hard baked and removed with a 50/50 blend of solvent and amine at room temperature.

E-GRADE® DGA™ Blend : Both solvents exhibit better removal time than NMP

E-GRADE® APM Blend : **MEOX** slightly to significantly outperforms NMP in all cases

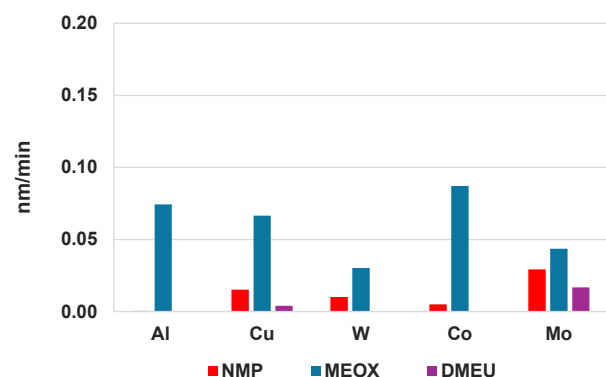
AEEA Blend : Both solvents exhibit slightly better removal times than NMP

Hygroscopicity



MEOX and **DMEU** are less hygroscopic than **NMP**, reducing the amount of water that is absorbed from the atmosphere for water sensitive processes.

Relative Corrosion Rate - 10% Aqueous Solutions



The relative corrosion rates of **DMEU** and **MEOX** were measured by linear polarization resistance and benchmarked against **NMP**. LPR testing determined that neither solvent is highly corrosive to metal surfaces.

SOLUBILITY GUIDE

The solubility of various materials was tested in multiple concentrations at 60°C, demonstrating that these solvents can be used as primary or cosolvents for these materials and offer alternatives to NMP. The maximum weight percent found to be soluble is listed below, however higher concentrations may be possible for some.

Material	PS	PMMA	BTR	BPDA	BTDA	ODPA	PMDA	6FDA	3,4'-ODA	pPDA
N-methyl-2-pyrrolidinone NMP	40%	40%	30%	5%	30%	10%	10%	30%	30%	30%
N,N'-Dimethylimidazolidinone E-GRADE® DMEU	40%	40%	30%	5%	30%	10%	10%	30%	30%	30%
3-Methyl-2-Oxazolidinone E-GRADE® MEOX	15%	40%	30%	<5%	10%	10%	5%	10%	30%	30%

PS : Polystyrene (M_w=195K)

PMMA : Polymethylmethacrylate

BTR : Benzoxazine thermoset Resins (ARALDITE® MT 35600 & MT35700)

BPDA : Biphenyl-tetracarboxylic acid dianhydride

BTDA : Benzophenone-tetracarboxylic dianhydride

ODPA : 4,4'-Oxydiphthalic anhydride

PMDA : Pyromellitic dianhydride

6FDA : 4,4'-(Hexafluoroisopropylidene) diphthalic anhydride

3,4'-ODA : 3,4'-Oxydianiline

pPDA : p-Phenylenediamine

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