Starting Formulation

SF 8002

Flame Retardant Prepreg Laminating Compound for High Temperature and Thin Laminating Applications
EPON™ Resin SU-8 and 1163

Introduction A combination of EPON Resin SU-8 high functionality epoxy resin and EPON Resin 1163 brominated epoxy resin are used in this formuation for finished laminates.

Suggested Uses

- Printed circuit boards qualifying under the NEMA G-11 and FR-5 specifications
- Thin laminates for multilayer circuitry qualifying under NEMA FR-4-UT and MIL-P-55617A, Type GF specifications
- Chopped glass molding compounds

Features

- Dry prepreg with up to 4 months or greater shelf life
- Rapid gelation in press
- High strength retention at 175 °C
- Good retention of peel strength and dimensional stability after exposure to hot solder, degreasing solvents, copper etching solutions, and plating solutions
- Thin laminates are non-burning when tested in accordance with ASTM D568

Formula

Material	Supplier	Pounds	Gallons
Formulation			
EPON Resin SU-8	Hexion	65.0	6.57
EPON Resin 1163	Hexion	35.0	2.32
Acetone	Shell Chemical Company	40.0	6.06
Dicyandiamide	SKW Corporation	4.0	0.35
2-Methoxyethanol	Union Carbide Corporation	40.0	4.98
1-Methylimidazole	BASF-Wyandotte Corporation	0.2	0.023
	Total Formulation	184.2	20.30

Mixing Instructions Dissolve the EPON Resin SU-8 and EPON Resin 1163 in acetone. This step requires a closed tank equipped with a heating jacket or coils, an agitator, and a water-cooled condenser. Solutions of these resins in acetone or other desired solvent line-ups can be supplied upon request. To eliminate the crystallization of brominated epoxy resin solutions during long term storage, a solution blend of EPON Resin SU-8 and the brominated epoxy resin, EPON Resin 1163, is suggested.

Dissolve the dicyandiamide into the 2-methoxyethanol using agitation at a temperature of 50 °C or higher. When all the dicyandiamide has been dissolved, add this warm solution to the resin solution at normal room temperature under moderate speed agitation. Continue the agitation while adding the 1-methylimidazole accelerator, and blend to a homogeneous, clear solution.

It is important to completely dissolve the dicyandiamide in the glycol ether solvent prior to adding it to the resin solution. Dicyandiamide is only sparingly soluble in acetone, and any undissolved particles will serve as “seeds” or nuclei for crystallation of the dissolved dicyandiamide during storage of the varnish.

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dicyandiamide during storage of the varnish.

Typical Formulation Properties

Table 1 / Properties of Laminating Solution

	Units	Value
Viscosity at 25 °C	cP	90
Density	lbs/gal	9.07
Pot life at 25 °C	wks	4-6
Gel time, stroke cure at 160 °C	sec.	117

Prepreg Procedures

Parameters affecting the resin pick-up and degree of “B” stage in commercial impregnation/ drying tower operation are:

- Viscosity, solids content, solvent volatility, accelerator concentration, and age of the varnish
- Clearances and fabric tension on squeeze rolls and/or doctor bars
- Residence time of impregnation fabric in the drying tower
- Air temperature and air velocity in the drying tower

Impregnation of the lightweight glass used in thin laminates is easily accomplished with this system using conventional wetting and squeeze-off assemblies. Use of higher solvent levels in this compound might be necessary to provide the wetting characteristics needed when using lightweight cloth.

Optimum conditions for prepreg production must be established for each manufacturing line, since industrial equipment varies considerably with respect to air velocity, the ratio of air exhausted to air recirculated, fabric tension, and varnish squeeze-off devices. Air temperatures as high as 175 °C are commonly used in commercial drying towers to process epoxy/dicy prepregs at high production speeds.

The usable life of this prepreg should be approximately three months when stored at normal room temperature or below, and in a low humidity environment.

Prepreg Properties

Table 2 / Prepreg Properties [1]

	Units	Value
B-stage schedule, 125°C in a forced air oven	min.	10
Resin pick-up	%	38-42
Percent flow, cured at 175°C and 150 psi	%	12

[1] Style 181 glass prepregs were prepared from laminating solutions aged at room temperature for periods ranging from 2 hours to 3 weeks.

Cure Properties

Table 3 / Press Cure Conditions and Laminate Properties

	Units	Value
Contact period		None
Platen temperature	°C	175
Pressure	psi	150
Time in press	min.	40

Time in press	min.	40
Post cure, 175 °C	min.	60

Formulation vs. Requirements

Table 4 / Properties of Formulation No. 8002 Glass Laminate [1] vs. NEMA G-5 Requirements

Laminate property	Conditioning	NEMA G-5 requirements	Test results
Resin content, weight percent	—	—	24
Thickness, inches	—	—	0.098
Flexural strength, psi			
Lengthwise	23 °C, 50% RH	6×10^4 min.	9.1×10^4
Crosswise	23 °C, 50% RH	5×10^4 min.	7.7×10^4
Flexural strength			
Retention %, at 150 °C	58,000 psi	—	—
Lengthwise	1 hour at 150 °C	50 min	64
Izod impact, ft•lb/inch notch			
Lengthwise	48 hours at 50 °C	7.0 min.	15.8
Crosswise	48 hours at 50 °C	5.5 min.	13..6
Peel strength, lb/inch width			
1 oz. copper	1 hour at 150 °C	3.0 min.	6.5
1 oz. copper	20 sec. solder dip	8.0 min.	8.5
Water absorption, %	24 hours at 23 °C	0.20 max.	0.06
Volume resistivity, megohm•cm	96 hours at 35 °C, 90% RH	10^6 min.	9×10^8
Surface resistivity	96 hours at 35 °C, 90% RH	10^4 min.	9×10^7
Dielectric constant, at 1 megacycle	23 °C, 50% RH	5.2 max.	5.1
	24 hours at 23 °C, in water	5.4 max.	5.3
Dissipation factor, at 1 megacycle	23 °C, 50% RH	0.025 max.	0.015
	24 hours at 23 °C, in water	0.035 max.	0.017
Dielectric breakdown (KV), parallel to laminations	23 °C, 50% RH	45 min.	> 56
	48 hours at 50 °C	40 min.	> 56
Flammability			
Burning time, seconds	—	15 max.	3
Burning length, inches	—	1 max.	Nil

[1] Twelve-ply 181 style. 1-550 finish glass.

Glass vs. Requirements

Table 5 / Propertles of Glass Laminate1 vs. MIL-P-55617A, Type GE and NEMA G-10-UT Requirement

Laminate property	Conditioning	Specification requirements	Test results
Resin content, weight percent	—	—	57
Thickness, inches	—	0.031 max.	0.003
Visual effect of solder dip	20 seconds at 200 °C	No effect	No effect
Peel strength,[2] lb/inch			
at 25 °C	20 second solder dip	6 min.	8.1
at 25 °C	5 temperature cycles[3]	6 min.	8.4
at 25 °C	1 hr. at 125 °C	7 min.	9.0
at 25 °C	Exposure to plating solution[4]	5 min.	76
at 125 °C	None	5 min.	6.1
Volume resistivity, ohm•cm			
at 25 °C	96 hours at 35 °C, 90% RH	10^{12} min.	11 x 10^{13}
at 125 °C	24 hours at 125 °C	109 min.	2.5 x 10^{10}
Surface resistivity, ohm•cm			
at 25 °C	96 hours at 35 °C, 90% RH	10^{10} min.	2.8 x 1.10^{12}
at 125 °C	24 hours at 125 °C	10^{9} min.	1.8 x 10^{11}
Dimensional stability, inches/inch	Etching	0.0005 max.	0.00010
	30 minutes at 170 °C	0.0005 max.	< 0.00005
	5 temperature cycles[3]	0.0003 max.	0.00029
Dielectric strength, volt/ml	48 hr. water immersion at 50 °C	750 min.	990
Dielectric constant, at 1 megacycle	None	5.4 max.	3.6
Dissipation factor, at 1 megacycle	None	0.035 max.	0.01
Flammability			
Burn time	None	15 max.	Non-burning
Burn length	None	12 max.	Non-burning

[1] Two-ply laminates prepared from Style 106, GB-399 Finish Glass.

[2] One ounce per square tool copper with “TC” treatment.

[3] Cycle conditions: 30 minutes at 125 °C, 15 minutes at 25 °C, 30 minutes at -65 °C, and 15 minutes at 25 °C.

[4] Exposed to hot trichlorethylene vapor, hot aqueous sodium hydroxide/sodium carbonate, hot aqueous sodium cyanide, and hot aqueous sulfuric acid/boric acid and solutions.

Storage	Recommendations regarding storage conditions can be obtained by visiting our web site at www.hexion.com

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These are starting formulations and are not proven in the user's particular application but are simply meant to demonstrate the efficacy of the products and to assist in the development of the user's own formulation. It is the user's responsibility to fully-test and qualify the formulation, along with the ingredients, methods, applications or equipment identified herein ("Information"), by the user's knowledgeable formulator or scientist, and to determine the appropriate use conditions and legal restrictions, prior to use of any Information.

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