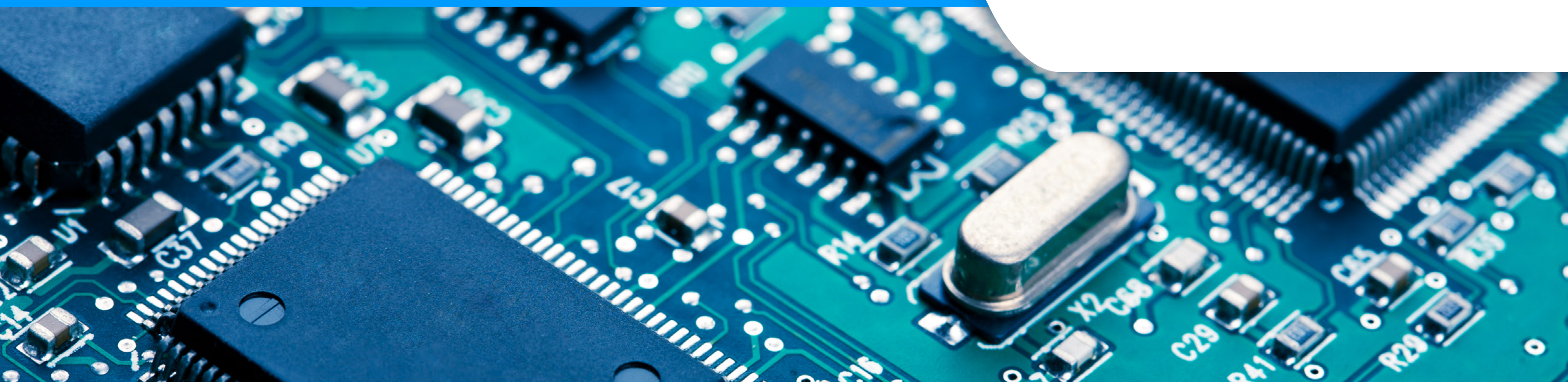
TECHNICAL UPDATE

CRAY VALLEY



Ricon® 100 in Polyphenylene Ether (PPE) Based Formulations for CCL and PWB

Introduction

Ricon® 100 is a low molecular weight, styrene-butadiene copolymer that is highly compatible with functionalized PPE resins commonly used in copper clad laminate (CCL) and printed wiring board (PWB) formulations. The structures of these two materials are shown in Figure 1. The butadiene-based structure gives Ricon 100 high moisture resistance and excellent dielectric properties. Ricon 100 contains reactive vinyl groups, which are peroxide curable to provide high glass transition temperature (Tg) and thermal resistance. Ricon 100 can be substituted for triallyl isocyanurate (TAIC) in PPE formulations, providing similar Tg and improved dielectric properties, as well as less volatility during handling and curing processes (Table 1 next page).

Ricon 100 is soluble in many solvents used in PWB manufacture as shown in Table 2, except acetone. When heated, its neat viscosity is low enough to allow solvent-free or reduced-solvent processing (Figure 2).

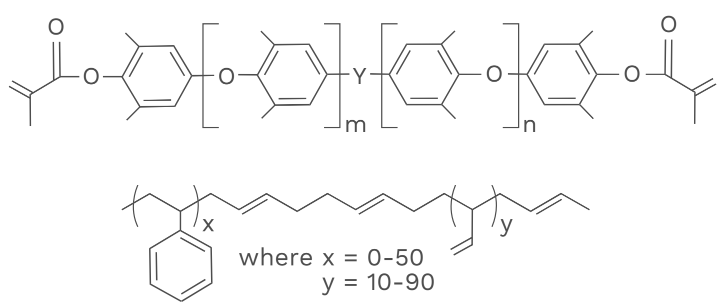


Figure 1: Structures of vinyl functional polyphenylene ether resin (left) and Ricon 100 (right).

BENEFITS

- Excellent reactivity
- Effective crosslinking
- Low D_k and D_f
- High T_g
- High thermal decomposition temperature
- Low water absorption
- Low coefficient of thermal expansion
- Excellent processability

TARGET MARKETS/ APPLICATIONS

- Copper clad laminate and printed circuit boards
- Structural composites
- Radomes
- Aerospace applications

ADDITIONAL INFO

- SDS/TDS: Ricon 100
- Technical data sheet: Ricon Resins – Hardeners in Polyphenylene Ether (PPE) Based Formulations for CCL and PWB

TotalEnergies

Table 1: Typical Ricon 100 Properties

Mn (g/mol)	Styrene (%)	Viscosity (cP @ 45°C)	1,2-Vinyl (%)	Tg neat (°C)	Tg cured* (°C)
4500	20	40,000	70	-25	15

*6% dicumyl peroxide added, then heat cured in DSC.

Table 2: Ricon 100 Solubility in Common Solvents at 10% and 50% solids*

MEK		Heptane		Acetone		Toluene		Xylene		PGMEA		Ethyl Acetate	
10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%
S	S	S	S	I	I	S	S	S	S	S	S	S	S†

*After mixing and sitting for 8 hours. S = fully soluble, S† = soluble with visible strands, I = insoluble (separation)

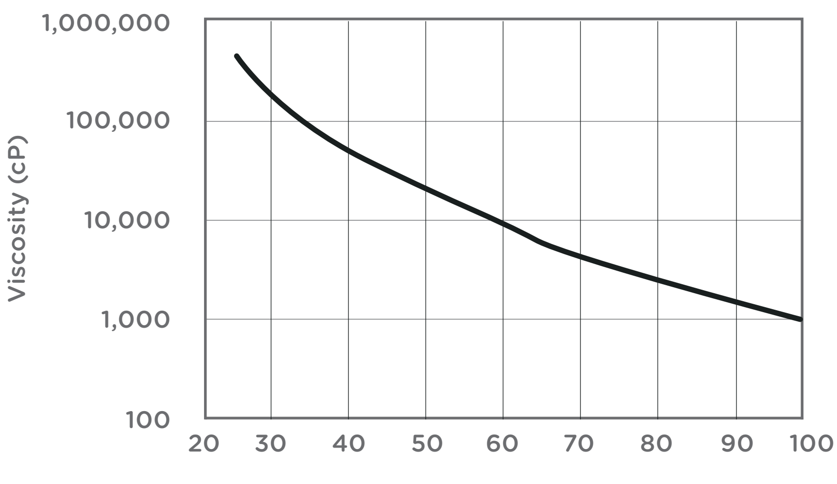


Figure 1: Ricon 100 viscosity vs. temperature.

Co-Reaction with Polyphenylene Ether (PPE) Resin

PPE is a frequently used resin in CCL and PWB applications. Once crosslinked, it imparts strength and heat resistance to circuit board substrates. TAIC is a tri-functional compound frequently used as a crosslinker for formulations with vinyl-functional PPE. However, at typical laminate cure temperatures of 150-200 °C, TAIC can volatilize and degrade. Ricon 100 can be substituted as a non-volatile crosslinker while also functioning as a reactive toughener in circuit board substrates. Figure 3 shows thermogravimetric analyses (TGA) of Ricon 100 and TAIC. The onset of decomposition is approximately 425 °C for neat Ricon 100 compared to 190 °C for TAIC.

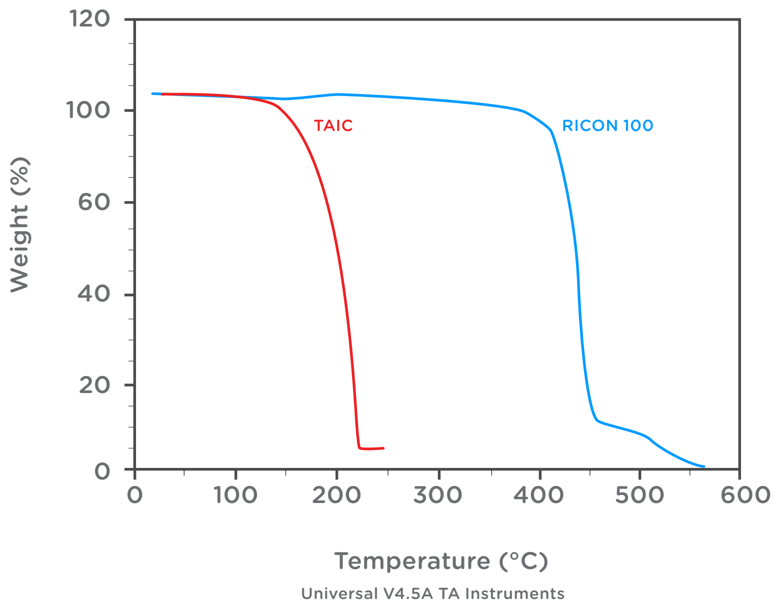


Figure 3: TGA in oxygen (10 ºC/min) of neat Ricon 100 and TAIC.

As shown in Table 3, Ricon 100 was compared to TAIC as a hardener for vinyl-functional PPE (Noryl™ SA9000 PPO™, SABIC) at a 1:1 weight ratio into toluene (55% solids) with dicumyl peroxide (3% solids basis). The solutions were applied to E-glass fiberglass woven cloth and dried at 110 °C to remove solvent. Three layers were stacked and cured at 100 psi and 160 °C for three hours, then postcured at 200 °C for one hour. Dielectric constant (Dk) and dissipation factor (Df) of the cured laminates were measured using a split-post dielectric resonator (SPDR, QWED Ltd) at 5 GHz. Tg was measured via tan delta from dynamic mechanical analysis (DMA). A significantly lower Df value can be achieved with Ricon 100 compared to TAIC, while Tg is only slightly lower.

Table 3: Properties of Fiber Glass Laminates

	Tg (°C)	D_k[1]	D_f[1]
PPE as is	160	2.540	0.0007
E-glass fiberglass	n/a	6.800	0.0070
PPE/TAIC (50:50 by weight)	186	4.139	0.0057
PPE/Ricon 100 (50:50 by weight)	178	4.059	0.0049

[1] For PPE, Dk and Df reported at 1 MHz (Noryl™ Resin SA9000 Technical Data Sheet, SABIC). For E-glass, D_k and D_f reported at 10 GHz (F. Wallenberger, editor. Fiberglass and Glass Technology, Springer, 3rd Ed., 2009, p.186.) All other values at 5 GHz.

Summary

Ricon 100 offers reactive toughening with less volatility during curing, with processible viscosity and solvent compatibility. By replacing TAIC with Ricon 100 in a PPE-based formulation, similar Tg can be achieved while improving dielectric properties.

About Cray Valley

Cray Valley is a global supplier of specialty chemical additives, hydrocarbon specialty chemicals, and liquid and powder tackifying resins used as ingredients in adhesives, rubbers, polymers, coatings, and other materials. Cray Valley has pioneered the development of these advanced technologies, introducing hundreds of products that enhance the performance of products in energy, printing, packaging, construction, tire manufacturing, electronics, and other demanding applications.

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