TECHNICAL UPDATE

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Solubility of Ricon® Resins When Formulated for Printed Wiring Boards

Benefits

- Polybutadiene backbone renders the final reaction product hydrophobic – low water absorption and high moisture resistance
- Liquid nature allows for easy mixing
- Non-tacky prepregs
- Excellent dielectrics – low dielectric constant and loss factor, minimal drift through a wide range of frequencies
- Peroxide curable
- Soluble in wide variety of solvents
- High chemical resistance

Target Markets

- Printed wiring (circuit) boards
- Structural composites
- Radomes
- Aerospace applications

Additional Information

SDS/TDS: Ricon® 100, Ricon® 154, Ricon® 157, Ricon® 184, Ricon® 257

Description

The Ricon family of laminating resins, shown in Table 1, are polybutadiene polymers that vary by molecular weight, and 1,2 vinyl content, which have a direct effect on Tg and viscosity. The viscosity values of low- and high-vinyl polybutadiene resins as well as styrene butadiene copolymers are shown in Figures 1, 2 and 3. These resins are unique in their excellent electrical properties and ease of handling. Solubility in a wide array of solvents allows for versatile processing and formulating.

Appearance: Clear liquid
Chemical Description: Polybutadiene
Molecular Weight (Mn): 1,400-8,000

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Table 1: Typical properties of Ricon resins.

Product	Description	Typical Properties		
		Molecular Weight (Mn, g/mol)	1,2 Vinyl (%)	Tg (°C)
Low Vinyl Content				
Ricon 130	Homopolymer of butadiene	2,500	28	-86
Ricon 131		4,500	28	-84
Ricon 134		8,000	28	-81
Ricon 138		2,000	40	-73
High Vinyl Content				
Ricon 150	Homopolymer of butadiene	3,900	70	-40
Ricon 152		2,900	80	-30
Ricon 153		4,700	85	-28
Ricon 154		5,200	90	-15
Ricon 156		1,400	70	-56
Ricon 157		1,800	70	-51
Styrene-Butadiene Copolymers				
Ricon 100	Butadiene-styrene random copolymer (25% styrene)	4,500	70	-15
Ricon 181	Butadiene-styrene random copolymer (28% styrene)	3,200	30	-65
Ricon 184		8,600	30	-57
Ricon 250/257*	Butadiene-styrene random copolymer (35% styrene)	5,300	70	--

**52% solids in toluene*

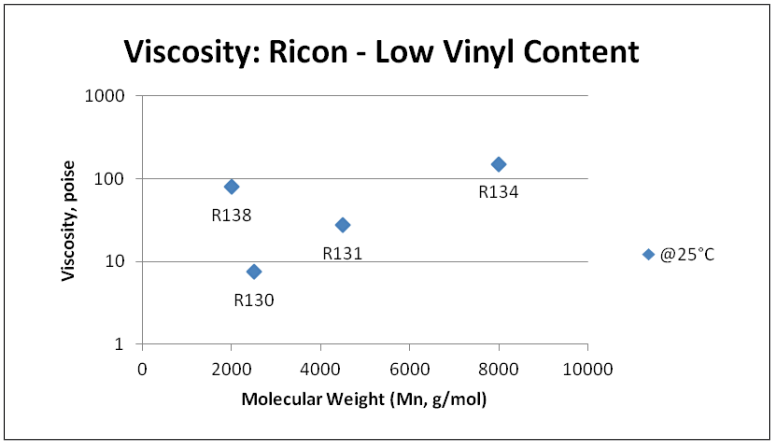


Figure 1: Viscosity (poise) of low-vinyl Ricon resins.

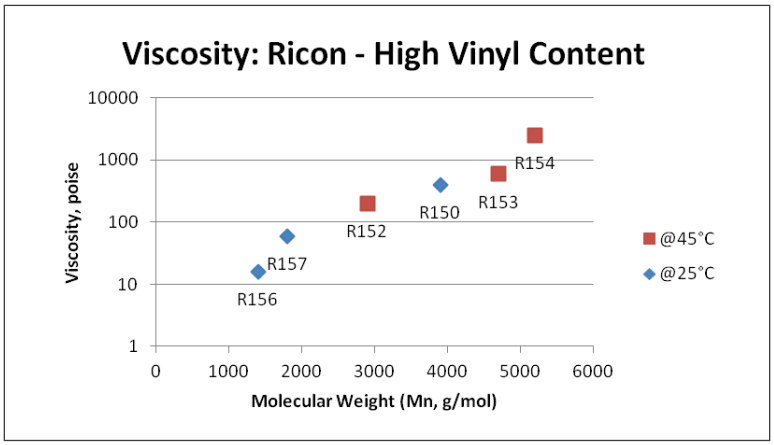
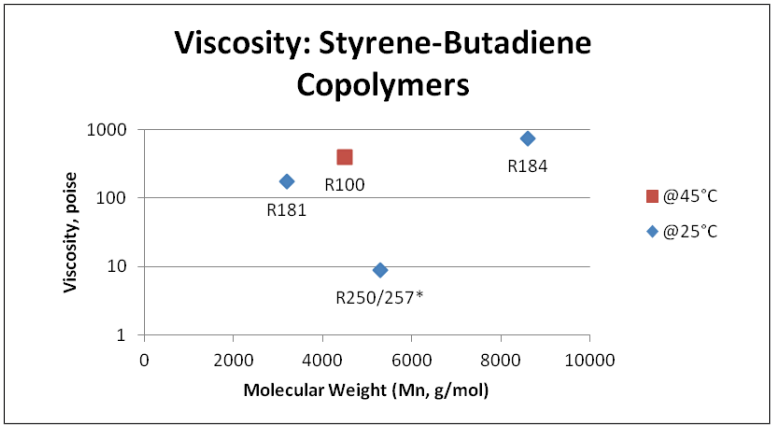


Figure 2: Viscosity (poise) of high-vinyl Ricon resins.



**52% solids in toluene*

Figure 3: Viscosity (poise) of styrene-butadiene copolymer Ricon resins.

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Solubility of select Ricon resins was evaluated using solvents common to the printed wiring board industry. Data points were taken at various mixing and rest times. The procedure and results are shown in Table 2.

Table 2: Procedure used to test solubility of Ricon resins with various solvents.

Solubility Procedure	
Solubility tested after Ricon and solvent combination at 10% and 50% solids:	
Step	**Description – solubility checked after each step**
1	Immediately after mixing
2	After mixing for 20 hours
3	After 4 hours rest
4	After additional 18 hours mixing
5	After additional 8 hours rest
6	After additional 24 hours rest
7	After additional 8 days rest
8	After additional 25 days rest

Initial mixing was completed using a Thermo Scientific Vortex Maxi Mix II, ambient conditions. Additional mixing was completed using an IKA HS250 mixer, ambient conditions.

The solubility of all tested Ricon resins is shown in Table 3. Excellent solubility is observed in methyl ethyl ketone, hexane, toluene, xylene and ethyl acetate. When using propylene glycol monomethyl ether acetate, solubility is excellent for three out of the five tested resins. Results indicate that Ricon is not soluble in acetone.

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Table 3: Ricon solubility in various solvents.

	Ricon Solutions – 10% solids | 50% solids													
Solvent	MEK		Heptane		Acetone		Toluene		Xylene		PGMEA		ethyl acetate	
Ricon 100	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**
Step 1	S	S	S	S	PS	PS	S	S	S	S	S	PS/I	S	PS/S
Step 2	S	S*	S	S	PS	PS/I	S	S	S	S	S	S	S	S*
Step 3	S	S*	S	S	PS/I	PS/I	S	S	S	S	S	S	S	S*
Step 4	S	S	S	S	I	PS	S	S	S	S	S	S	S	S
Step 5	S	S	S	S	I	I	S	S	S	S	S	S	S	S*
Step 6	S	S	S	S	I	I	S	S	S	S	S	S	S	S*
Step 7	S	S	S	S	I	I	S	S	S	S	S	S	S	S
Ricon 154	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**
Step 1	S	S	S*	S	PS	PS	S	S	S	S	PS	PS	S*	PS/S
Step 2	S	S	S	S	PS	PS/I	S	S	S	S	PS	S	S	S
Step 3	S	S	S	S	PS	PS/I	S	S	S	S	PS/I	S	S	S*
Step 4	S	S	S	S	I	PS/I	S	S	S	S	PS/I	S	S	S*
Step 5	S	S	S	S*	I	I	S	S	S	S	PS/I	S	S	S*
Step 6	S	S	S	S	I	I	S	S	S	S	I	PS	S	S
Step 7	S	S	S	S	I	I	S	S	S	S	I	I	S	S
Ricon 157	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**
Step 1	S	S	S	S	PS	PS	S	S	S	S	S	S	S*	S*
Step 2	S	S	S	S	PS	PS	S	S	S	S	S	S	S	S
Step 3	S	S	S	S	I	I	S	S	S	S	S	S	S	S*
Step 4	S	S	S	S	PS/I	PS	S	S	S	S	S	S	S	S
Step 5	S	S	S	S	I	I	S	S	S	S	S	S	S	S*
Step 6	S	S	S	S	I	I	S	S	S	S	S	S	S	S
Step 7	S	S	S	S	I	I	S	S	S	S	S	S	S	S

Note: S = soluble, PS = partially soluble (turbid solution), I = insoluble (separation)

**Very light "strands" of material*
***Hazy*

Table 3: Ricon solubility in various solvents (continued).

	Ricon Solutions – 10% solids | 50% solids													
Solvent	MEK		Heptane		Acetone		Toluene		Xylene		PGMEA		ethyl acetate	
Ricon 184	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**
Step 1	S	S	S	S	PS	PS	S	S	S	S	PS	PS	S	S
Step 2	S	S	S	S	I/PS	I/PS	S	S	S	S	PS	S	S	S
Step 3	S	S	S	S	I/PS	I	S	S	S	S	I	S	S	S
Step 4	S	S	S	S	I/PS	I	S	S	S	S	PS	S	S	S
Step 5	S	S	S	S	I/PS	I	S	S	S	S	PS	S	S	S
Step 6	S	S	S	S	I/PS	I	S	S	S	S	PS	S	S	S
Step 7	S	S	S	S	I	I	S	S	S	S	I	I	S	S
Ricon 257	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**	**10%**	**50%**
Step 1	S	S	S**	S	I	S	S	S	S	S	S	S	S	S
Step 2	S	S	S**	S**	I	S	S	S	S	S	S	S	S	S
Step 3	S	S	S**	S**	I	S	S	S	S	S	S	S	S	S
Step 4	S	S	S**	S**	I	S	S	S	S	S	S	S	S	S
Step 5	S	S	S**	S**	I	S	S	S	S	S	S	S	S	S
Step 6	S	S	S**	S**	I	S	S	S	S	S	S	S	S	S
Step 7	S	S	S**	S**	I	I	S	S	S	S	S	S	S	S

Note: S = soluble, PS = partially soluble (turbid solution), I = insoluble (separation)

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Summary

Ricon resins have a broad window of solubility that allows for diverse formulating. The low molecular weight lends to ease of incorporation at ambient conditions without the need for elevated temperatures.

Figure 4 illustrates the general solubility trends for Ricon resins using Hansen Solubility Parameters. The graph uses the energy from hydrogen bonds and the energy from dipolar intermolecular forces to delineate solubility. The black dots are the solubility parameters of the solvents tested in this report. The dotted red box separates degrees of solubility: inside the dotted red box designates solubility with a wide variety of chemicals, the area immediately around the red dotted line represents partial solubility, and the area outside of the dotted line represents insolubility. Note that these are general trends that will tend to fluctuate according to molecular weight, vinyl percent and resin composition.

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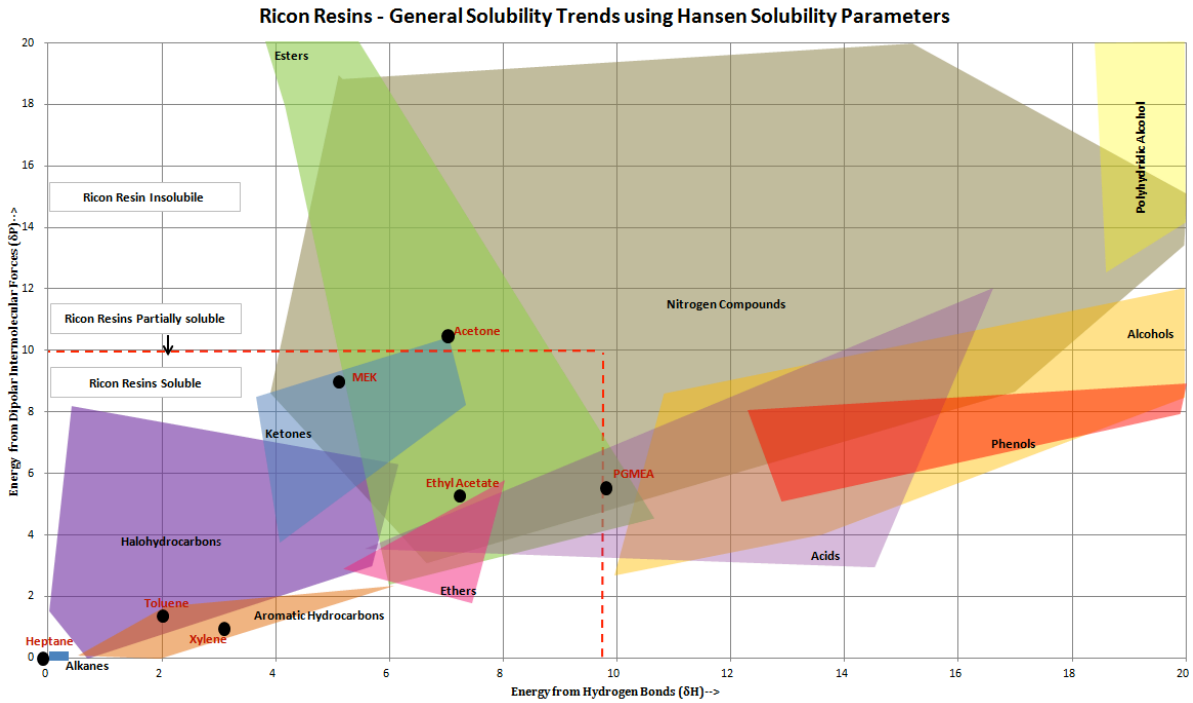

Figure 4: General solubility of Ricon resins using Hansen Solubility Parameters.

For more information, please visit our website at **www.crayvalley.com**

About Total Cray Valley

Total Cray Valley is the premier 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. Total 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 manufacture, electronics and other demanding applications.

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