FormuLITE™

Bio-based Epoxy Formulations

The FormuLITE Series is designed to provide composite manufacturers with a high performance, bio-based two-component epoxy system. FormuLITE is comprised of modified epoxy resins (part A) and amine hardeners (part B) that are both based on components derived from renewable resources.

FormuLITE is suitable for the manufacturing of medium to large size composite parts by wet lay-up, resin transfer molding (RTM), lamination and vacuum infusion.

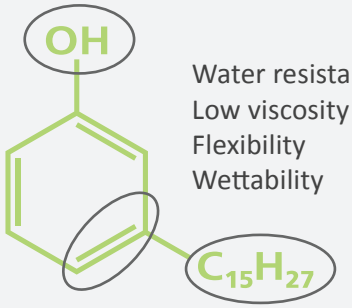
Properties & Performance:

- Low viscosity and excellent wetting of the reinforcements (glass, carbon and natural fibers).
- Fast reactivity with extended pot life.
- Well balanced thermal and mechanical properties.
- Good resistance to water uptake, acid and alkali solutions.
- Bio-content ranging from 27% to 45% by weight.
- Excellent alternative to traditional petroleum-based two-component systems.

CNSL Bio-based Technology

Cardanol is the main **renewable** component used as building block in the FormuLITE product line. Cardanol is a unique, natural phenolic material obtained by distilling Cashew Nutshell Liquid (CNSL) that **does not interfere with the food chain.** The cardanol molecule is composed of an aromatic ring with an OH group and a long aliphatic side chain, which bring valuable intrinsic benefits to composite materials.

Low temperature cure
Fast cure and processing rates
Excellent adhesion



Water resistance
Low viscosity
Flexibility
Wettability

Chemical and thermal shock resistance

Cardolite
Chemistry for Tomorrow

FormuLITE Properties Selection Chart

Part A Part B	FormuLITE 2500A FormuLITE 2401B	FormuLITE 2501A FormuLITE 2401B	FormuLITE 2502A FormuLITE 2401B	FormuLITE 2501A FormuLITE 2002B	FormuLITE 2501A FormuLITE 2405B
Mix ratio by wt	100:30	100:31	100:33	100:52	100:41
Initial Mix Viscosity[1] at 25°C (cPs)	700	905	480	1100	1635
Initial Mix Viscosity[1] at 40°C (cPs)	242	302	175	377	650
Pot life[2] at 25°C (min)	105	95	125	58	28
Pot life[2] at 40°C (min)	57	50	63	27	11
Suggested cure cycles[3]	4-8 hrs at RT + 2-4 hrs at 50-70°C* + 2-3 hrs at 80-100°C	4-8 hrs at RT + 2-4 hrs at 50-70°C* + 2-3 hrs at 80-100°C	4-8 hrs at RT + 2-4 hrs at 50-70°C* + 2-3 hrs at 80-100°C	4-8 hrs at RT + 2-3 hrs at 70-80°C	24hrs at RT (+ 3-4hrs at 60°C for optimal curing)
Tg[4] (°C)	92	100	88	73	79
Tensile Strength[5] (MPa)	62	69	66	52	67
Tensile Modulus[5] (MPa)	2615	3134	2893	2599	2608
Elongation at Fmax[5] (%) Elongation at break[5] (%)	4.8 6.4	5.2 6.6	3.4 3.4	4.3 11.3	5.08 6.75
Flexural Strength[6] (MPa)	92	113	96	73	106
Flexural Modulus[6] (MPa)	2262	2788	2484	2104	2942
Bio-content[7] (% by wt)	36.6	34.0	27.0	45.4	36.9
Recommended Processes	Infusion, RTM, VARTM, lamination, wet lay-up	Infusion, RTM, VARTM, lamination, wet lay-up	Infusion, RTM, VARTM, lamination, wet lay-up	Wet lay-up, RTM, VARTM, lamination, infusion of smaller parts	RTM, VARTM, lamination, wet lay-up
Key Advantages	Good Tg, potlife, bio-content and mechanical properties	Higher Tg and better mechanical properties	Very low viscosity, longer pot life	High bio-content, faster reactivity	Fastest reactivity, room temperature cure and mould release.

[1] ASTM D2196
[2] Pot life determined upon viscosity increase up to 10,000 cps
[3] Curing and post-curing cycles should be optimized according to the temperature of the working space, the size of the composite part and the available curing equipment, and verified through testing on the resulting composite.
* Optional low temperature post curing step for demolding prior to final post-cure
[4] ASTM D3418-99
[5] ASTM D638-10
[6] ISO 178
[7] Calculated

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