



THE CARBON NANOTUBE SPECIALIST

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EPOCYL

Ref: EPOCYL™ NC R2HM-01 – 3 March 2009 - V11

EPOCYL™ NC R2HM-01 Product Data - Formulated Resin System for Pre-preg Process

General information

Description

EPOCYL™ NC R2HM-01 is a formulated epoxy based resin system for hot melt pre-preg and pressure molding processes, modified with our own Carbon Nanotubes (CNT), specifically developed to enhance the mechanical properties of the final fiber reinforced composite materials.

Applications: High performance composite parts

- Automotive (bumpers and other structural parts)
- Marine, especially sailing boats (structural outer shell in carbon fiber composite, masts and other generic structural parts)
- Industrial parts (rollers, doctor-blades and wind-mill blades)
- Sporting equipments (bike frames, hockey sticks, tennis rackets, skis and golf shafts)
- Aerospace (structural parts and interiors)

Advantages

- Improved fracture toughness (G1C) of over 100%
- Improved strength perpendicular to, and at +/- 45° to fiber direction of over 15%
- Reduced CTE of over 15%
- No reduction of the Tg
- Easy and ready to use system for hot melt pre-preg processes
- Higher uniformity of temperature during curing (avoids hot-spots)

Typical properties of EPOCYL™ NC R2HM-01

Aspect:	Solid, black
Epoxy equivalent:	3,45 – 3,50 eq/kg
Density at 25 °C:	1,15 – 1,20 g/ml
Storage temperature:	5 – 40 °C

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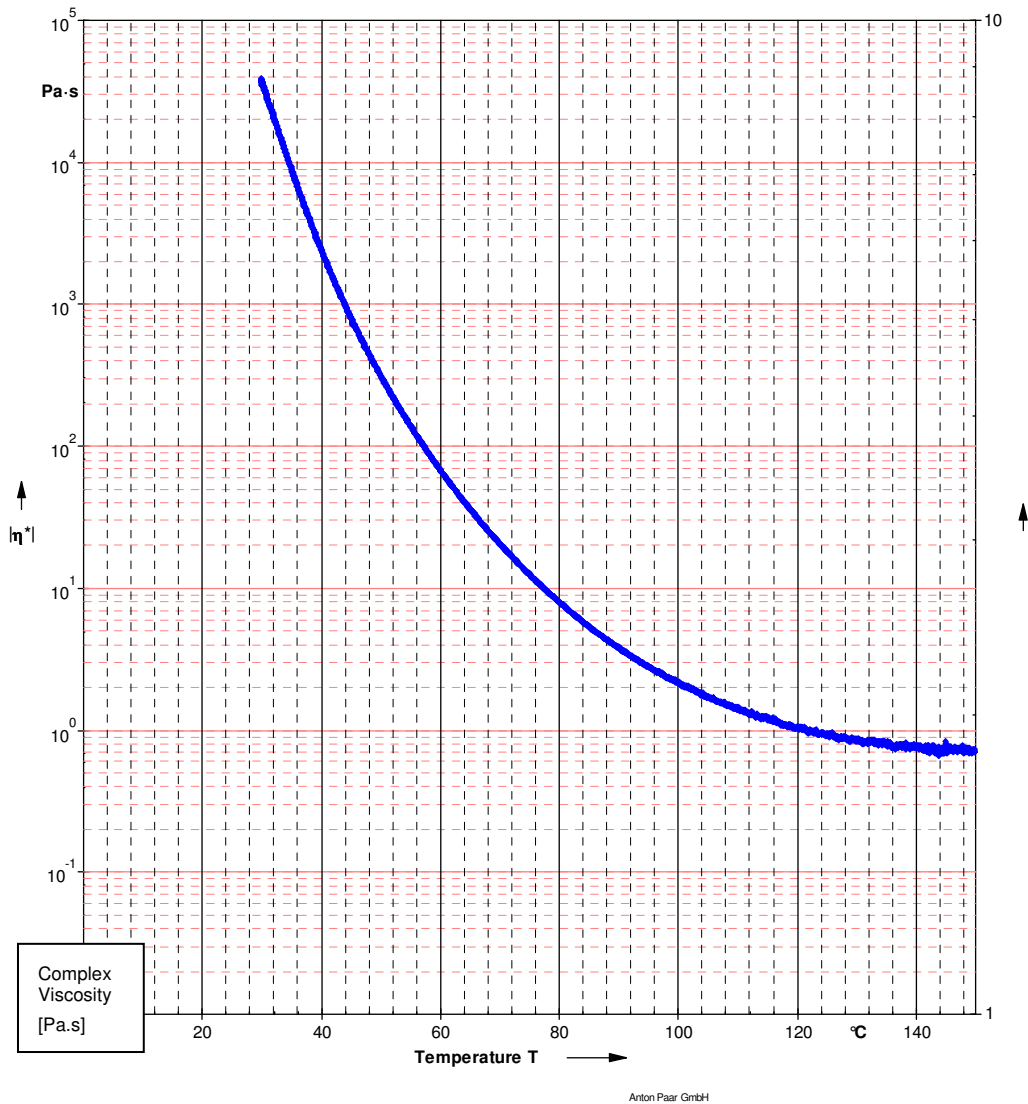
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Viscosity Profile of the EPOCYL™ NC R2HM-01 alone (without Hardener)



Curing agents

EPOCYL™ NC R2HM-01 can be cured or cross-linked with different types of curing agents depending on the properties desired in the final composite.

The type of curing agent suggested is Aradur 5021 (Huntsman). Anyhow any curing agents based on dicyandiamide are the preferred ones to be used in combination with EPOCYL™ NC R2HM-01.

It is important to respect the ratio hardner or hardner/accelerator with the epoxy equivalent of the EPOCYL™ NC R2HM-01.

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Properties of the curing agent Aradur 5021 (values obtained by the technical data sheet from Hutsman)

Aspect:	White paste
Viscosity at 25°C:	70000 – 90000 mPas
Density at 25°C:	1,0 g/ml
Storage temperature:	8 °C

Processing conditions in pure hot-melt conditions (solvent free)

Mixing conditions

Firstly the resin EPOCYL™ NC R2HM-01 needs to be heated up to a temperature between 70 and 90 °C and make a first mix to better homogenize all the system. Add the hardner paste (e.g. Aradur 5021), which needs to be at about 25°C and stir well until obtaining a homogenous mix. Time, temperature and speed of the mixing may need to be adapted to reach a final homogenous mix. All common equipments available in any pre-preg and composite facilities are good to achieve a good and homogeneous mixture.

Impregnation conditions

The knife needs to be kept at a temperature about 80°C, while in the heating zone the temperature suggested should be in the range of 60 – 70 °C. Special processing conditions are not required, compare to any other standard hot melt pre-preg system. The resulting tack level it will be medium-dry but it can be adjusted by increasing or decreasing the temperature and the residence time in the heating zone.

Mix ratio

EPOCYL™ NC R2HM-01	100 pbw (parts by weight)
Aradur 5021	22 pbw

Gel time (measured with the hot plate system):

- About 60 min. at 100 °C
- About 15 min at 120°C
- About 8 min at 130°C
- About 5 min at 140°C

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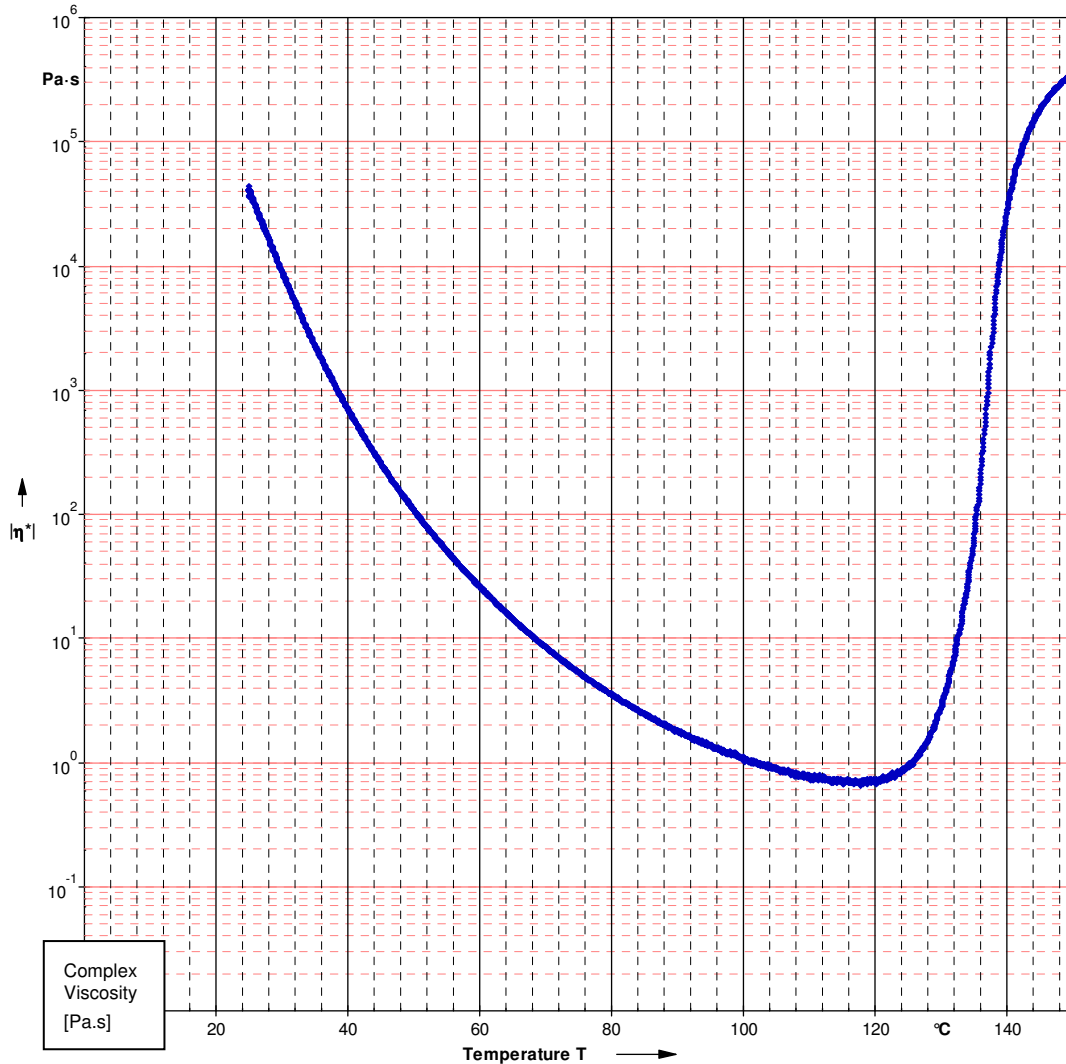
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Viscosity Profile of the EPOCYL™ NC R2HM-01 with Hardener (in this specific case Aradur 5021)



Curing cycles suggested

Curing	Post Curing	Tg (measured by DSC)
5h at 100 °C		About 120 °C
1h at 120 °C		About 120 °C
2h at 120 °C		About 120 °C
1h at 130 °C		About 120 °C
30' at 140 °C		About 120 °C
1h at 120 °C	2h at 140 °C	About 125 °C

Heating ramp suggested: 3-4°C/min. Cooling ramp suggested: 2-3°C/min.

Shorter curing cycles are possible but specific testing may be needed to validate.

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Processing conditions using solvent

Mixing conditions

Firstly the resin EPOCYL™ NC R2HM-01 needs to be heated up to a temperature between 80 and 90°C and make a first mix to better homogenize all the system, cool down then the resin between 40 and 50°C. Add the solvent (preferably Methyl Ethyl Ketone – MEK) mixing gently up to the desired viscosity of the resin. Cool down the resin up to 25°C (RT) and add then the desired amount of hardner paste (e.g. Aradur 5021), which needs to be at about 25°C and calculated on the pure resin content without any solvent, stir well until obtaining a homogenous mix. Time, temperature and speed of the mixing may need to be adapted to reach a final homogenous mix. Not special machines are required for the mixing, all common equipments available in any pre-preg and composite facilities are good to achieve a good and homogeneous mixture.

Amount of solvent (MEK) added (% by weight)	Complex Viscosity measured at 25°C [Pa.s]
0	40.000
10	50 – 70
20	35 – 50
30	10 – 25
40	10 – 20

Impregnation conditions

The temperature in the resin bath, speed of impregnation, residence time of the fiber/textile in the oven, temperature and ventilation level for solvent evaporation and other parameters needs to be adjusted to obtain the desired tack level of the final pre-preg.

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Properties of the cured and fiber reinforced composite

Unless otherwise stated the values given are for pressed laminates comprising 8 layers of unidirectional (UD) carbon fibers high tenacity (Tenax 12K HTS 5631) of 230 g/m². Fiber volume fraction: 58-60%.

Curing cycle: 1h at 120°C + 2h at 140°C combined with low pressure.

PROPERTIES	STANDARD	UNIT	UNMODIFIED RESIN	EPOCYL™ NC R2HM-01
Fracture toughness	ASTM 5528	[J/m ²]	500	1200
Transversal tensile test (perpendicular to the fiber direction)				
Tensile Modulus	ASTM D3039	[GPa]	7,4	6,6
Tensile Strength	ASTM D3039	[MPa]	51,7	53,5
Elongation at Break	ASTM D3039	[%]	0,78	0,9
Compression Strength	ASTM D3410	[MPa]	482	553
Tensile test in fiber direction +/- 45° to tensile axis				
Tensile Modulus	ASTM D3039 and D3518	[GPa]	12	10
Tensile Strength	ASTM D3039 and D3518	[MPa]	172	200
Elongation at Break	ASTM D3039 and D3518	[%]	11	11
CTE - Coefficient of thermal expansion – thermo mechanical analysis		[x 10 ⁻⁵ / °K]	3,58	2,97
ILSS - Interlaminar Shear Strength	ASTM D2344	[MPa]	66	66
Longitudinal tensile test (fiber direction)_ These values are normalized to 60% of fiber volume fraction				
Tensile Modulus	ASTM D3039	[GPa]	140	140
Tensile Strength	ASTM D3039	[MPa]	1800	1750
Elongation at Break	ASTM D3039	[%]	1,7	1,4
Flame Resistance	UL 94		Easy flammability, good flame propagation	flammability, no flame propagation nor dripping (V0)

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Electrical conductivity

This value is measured for the pure EPOCYL™ NC R2HM-01, without any fiber reinforcements.

$2,5 \cdot 10^{-6}$ [S/m] = $4 \cdot 10^3$ [$\Omega \cdot \text{cm}$]

Important

All information is believed to be accurate but is given without acceptance of liability. Users should make their own assessment of the suitability of any product for the purposes required.

For technical assistance, sales or further information, please contact us :

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