

Issued: August 2006

## EPIKOTE™ Resin MGS™ LR 135 and EPIKURE™ Curing Agent MGS™ LH 133-138

### CHARACTERISTICS

<b>Approval</b>	German Lloyd
<b>Application</b>	Rotor blades for wind turbines, boatbuilding as laminating and adhesive resins (wood-epoxy construction), sporting goods, moulds, tools and other devices
<b>Operational Temperature</b>	-60 °C up to +50 °C (-76 °F up to 122 °F) without heat treatment -60 °C up to +80 °C (-76 °F up to 176 °F) after heat treatment
<b>Processing</b>	At temperatures between 15 °C and 50 °C (59-122 °F) all common processing methods
<b>Features</b>	Pot life of approx. 10 min. up to more than 10 h can be used without heat treatment (Hardeners 133-135) physiologically compatible
<b>Special Modifications</b>	LR 135 LV: low viscosity LR 135 T: thixotropic LR 135 W: white
<b>Storage</b>	Shelf life of 24 months in originally sealed containers

### APPLICATION

Laminating resin system approved by the **German Lloyd**. It contains no solvents and fillers and is available for different pot lives. The system is used for processing of glass, carbon and aramide fibres, featuring high static and dynamic loadability. This system has very good adhesive properties with wood and other materials. In boatbuilding, laminating resin LR 135 can be used universally, especially for wood-epoxy constructions.

The range of pot lives is between approx. 10 min. and more than 10 hours. This enables a selection of the optimum system for all processing methods. After precuring at room temperature, the manufactured components are workable and demouldable. The final properties, however, will only be obtained after post curing at temperatures of more than 40 °C (104 °F). At room temperature, the fast hardeners 133-135 are processable and demouldable after 6-12 hours, while the very slow hardeners 136 to 138 have curing periods of 2-4 days at room temperature.

Laminates produced with this system result in high-gloss and non-tacky surfaces, even with unfavourable curing conditions, e.g., lower temperatures and/or high humidities. The mixing viscosity guarantees a fast and complete impregnation of the reinforcement fibres, however, the resin will not drain out of the fabrics on vertical surfaces.

Due to the chemical characteristics of this system, we do not expect any problems concerning compatibility (e.g., blisters, tearing or changes in colour) when it is processed with gelcoats. However, comprehensive tests are indispensable.

Epoxy resins are super-cooled liquids, therefore crystallisation is immanently possible. In an early stage, crystallisation is visible as a clouding, and can progress to a stage where the resin becomes a wax-like solid. Crystallisation can be reversed by slow heating of the product to approx. 40-60 °C. This physical phenomenon is reversible and is no restriction to quality after removal; in fact a high purity of material will increase a tendency for crystallisation.

Although LR 135 is unlikely to crystallise at low temperatures, storage conditions of 15-30 °C and low humidity are recommended. After dispensing material, the containers must again be closed carefully to avoid contamination or absorption of water. All amine hardeners show a chemical reaction when exposed to air, known as "blushing." This reaction is visible as white carbamide crystals, which could make the materials unusable.

The materials have a shelf life of minimum 2 years when stored in their originally sealed containers.

Due to selected raw materials, we expect only minor problems concerning skin irritation and allergies during processing. The relevant industrial safety regulations for the handling of epoxy resins and hardeners and our instructions for safe processing are to be observed.

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## SPECIFICATIONS

		Laminating Resin LR 135
Density	[g/cm <sup>3</sup> ]	1,14 - 1,18
Viscosity	[mPas]	2.300 - 2.900
Epoxy equivalent	[g/equivalent]	170 - 189
Epoxy value	[equivalent/100g]	0,53 - 0,59
Refractory index		1,5590 - 1,6530

		Laminating Resin LR 135 LV
Density	[g/cm <sup>3</sup> ]	1,14 - 1,18
Viscosity	[mPas]	1.000 - 1.500
Epoxy equivalent	[g/equivalent]	170 - 189
Epoxy value	[equivalent/100g]	0,53 - 0,59
Refractory index		1,5540 - 1,5560

		Hardener LH 133	Hardener LH 134	Hardener LH 135
Density	[g/cm <sup>3</sup> ]	1,04 - 1,08	1,03 - 1,07	0,98 - 1,02
Viscosity	[mPas]	400 - 650	150 - 500	50 - 150
Amine Value	[mg KOH/g]	450 - 530	420 - 530	440 - 500
Refractory index		1,5550 - 1,5650	1,5640 - 1,5700	1,5090 - 1,5125

		Hardener LH 136	Hardener LH 137	Hardener LH 138
Density	[g/cm <sup>3</sup> ]	0,94 - 0,98	0,94 - 0,98	0,93 - 0,96
Viscosity	[mPas]	20 - 100	10 - 50	10 - 50
Amine value	[mg KOH/g]	450 - 500	450 - 500	450 - 550
Refractory index		1,4110 - 1,5120	1,4500 - 1,4700	1,4570 - 1,4590

**Measuring conditions: measured at 25 °C / 77 °F**

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**PROCESSING DETAILS**

	Laminating resin LR 135	Hardeners LH 133-138
Average EP - Value	0,56	-
Average amine equivalent	-	62

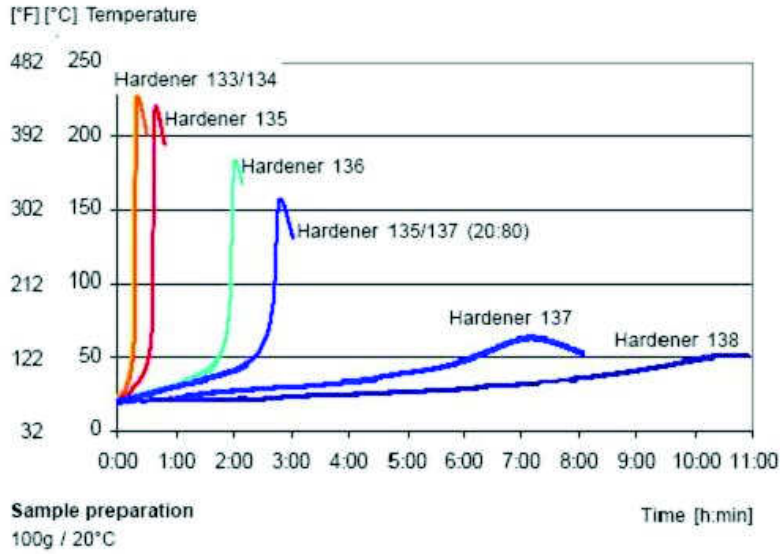
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**MIXING RATIOS**

	Laminating resin LR 135 : Hardeners LH 133-138
Parts by weight	100 : 35 ± 2
Parts by volume	100 : 41 ± 2

The mixing ratio stated must be observed carefully. Adding more or less hardener will not result in a faster or slower cure, but in incomplete curing with limited performance, which cannot be corrected in any way. Resin and hardener must be mixed carefully. Mix until no clouding is visible in the mixing container. Special attention must be paid to the walls and bottom of the mixing container.

**TEMPERATURE DEVELOPMENT**



The optimum processing temperature is in the range between 20 and 40 °C. Higher processing temperatures are possible, but will shorten pot life. An increase in temperature of 10 °C will halve the pot life. Water (for example due to high humidity or contained in fabrics or fillers) causes an acceleration of the resin/hardener reaction. Different temperatures and humidities during processing have no significant effect on the mechanical properties of the cured product.

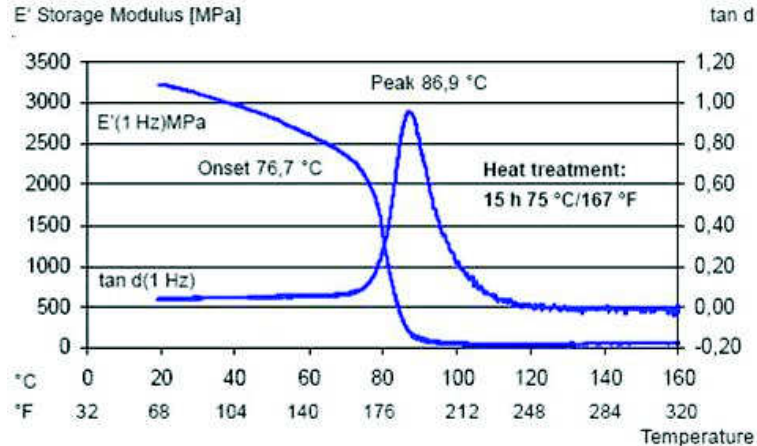
**GEL TIME**

	Laminating Resin LR 135					
	Hardener LH 133	Hardener LH 134	Hardener LH 135	Hardener LH 136	Hardener LH 137	Hardener LH 138
68-77 °F 20-25 °C	1-2 h	2-3 h	4-5 h	6-7 h	11-12 h	15-20 h
104-113 °F 40-45 °C	30 min	40 min	50 min	1-2 h	3-4 h	6-7 h

**Film thickness 1 mm at different temperatures**

**DMA**

**DMA-Measuring after heat treatment**  
**DMA-T<sub>g</sub>(peak) tan delta: Laminating resin L135 with hardener 137**



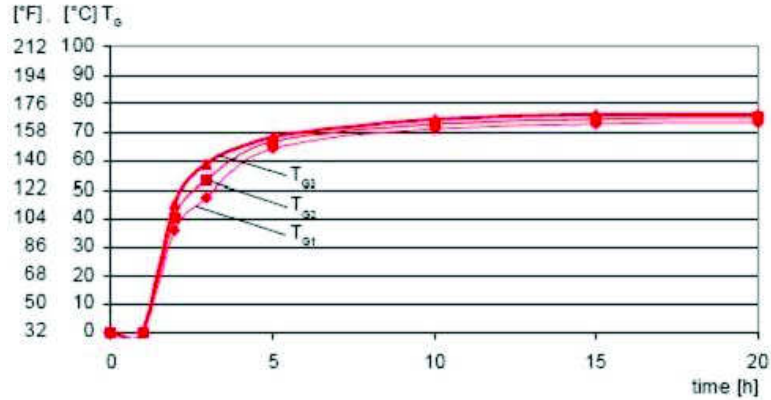
**Measuring conditions:**  
 Coupon thickness: 2 mm  
 Heating rate: 2 K/min  
 Frequency: 1 Hz

**TG CONDITIONED**

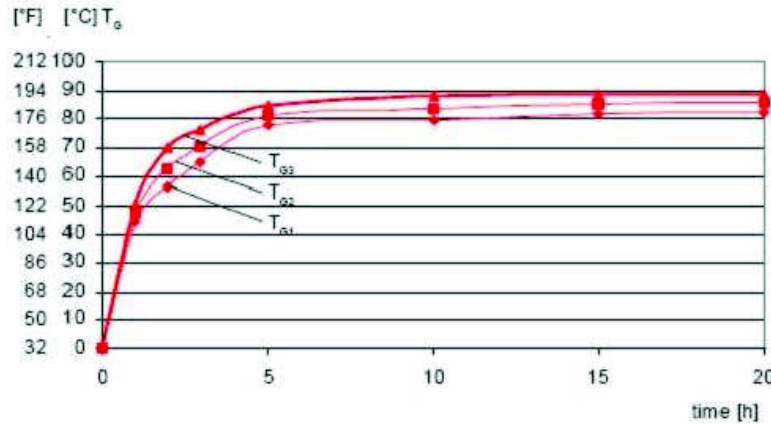
	Laminating resin LR 135 : Hardener LH 137
Unconditioned	176 - 184 °F 80 - 90 °C
Conditioned	149 - 167 °F 65 - 75 °C

DEVELOPMENT OF TG

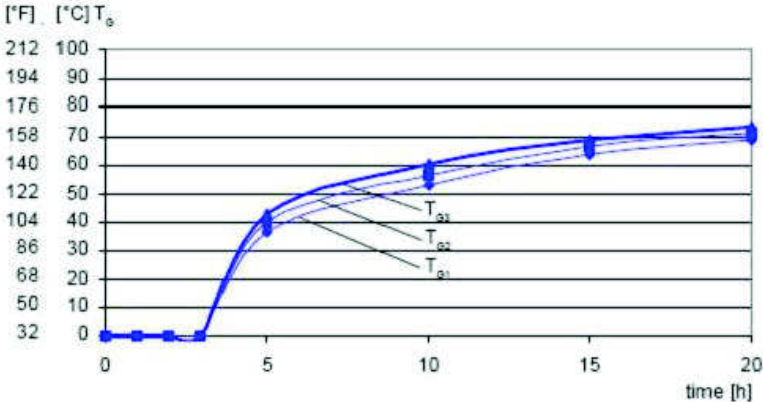
T<sub>g</sub> development at 50 °C (122 °F)/Laminating resin L135 with Hardener 135



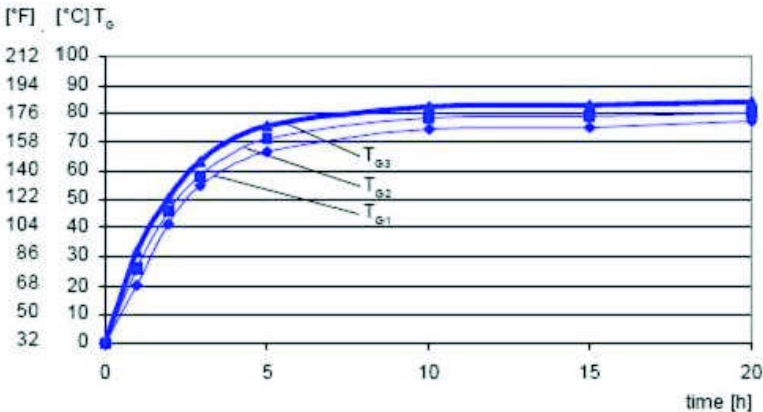
T<sub>g</sub> development at 70 °C (158 °F)/Laminating resin L135 with Hardener 135



**T<sub>g</sub> development at 50 °C (122 °F)/Laminating resin L135 with Hardener 137**



**T<sub>g</sub> development at 70 °C (158 °F)/Laminating resin L135 with Hardener 137**





**MECHANICAL DATA**

Mechanical Data of Neat Resin		
Density	[g/cm <sup>3</sup> ]	1,10 - 1,20
Flexural strength	[N/mm <sup>2</sup> ]	100 - 130
Modulus of elasticity	[kN/mm <sup>2</sup> ]	2,9 - 3,2
Tensile strength	[N/mm <sup>2</sup> ]	68 - 80
Compressive strength	[N/mm <sup>2</sup> ]	80 - 100
Elongation of break	[%]	7.0 - 10.0
Impact strength	[KJ/m <sup>2</sup> ]	30 - 50
Water absorption at 23 °C	24 h [%] 7 d [%]	0,10 - 0,50 0,20 - 0,80
Fatigue strength under reversed bending stresses acc. to DLR Brunsw.	10 % 90 %	exp. > 1 x 10 <sup>6</sup> exp. > 2 x 10 <sup>6</sup>
Curing: 24 h at 23° C (74° F) + 15 h at 60° C (140° F) Typical data according to WL 5.3203 Parts 1 and 2 of the GERMAN AVIATION MATERIALS MANUAL		

**Advice:** Mechanical data are typical for the combination of laminating resin LR 135 with hardener LH 135. Data can differ in other applications.

**Data of Reinforced Resin – Static Tests Standard Climate:**

	GRC Glass Fibre	CRC Carbon Fibre	SRC Aramide Fibre
Reinforced with:			

Flexural strength	[N/mm <sup>2</sup> ]	480 - 530	650 - 690	290 - 320
Tensile strength	[N/mm <sup>2</sup> ]	440 - 480	450 - 500	380 - 450
Compressive strength	[N/mm <sup>2</sup> ]	380 - 400	400 - 450	130 - 150
Interlaminar shear strength	[N/mm <sup>2</sup> ]	38 - 42	40 - 45	27 - 30
Modulus of elasticity	[kN/mm <sup>2</sup> ]	17 - 19	35 - 40	14 - 17

**GRC samples:** 16 layers of glass fabric, 4H satin, 275 g/m<sup>2</sup> (8.5 oz/sq.yd.), 4 mm (0.16 in) thick

**CRC samples:** 8 layers of carbon fabric, plain, 200 g/m<sup>2</sup> (5.9 oz/sq.yd.) 2 mm (0.08 in) thick

**SRC samples:** 15 layers of aramide fabric, 4H satin, 170 g/m<sup>2</sup> (5.0 oz/sq.yd.) , 4 mm (0.16 in) thick

Fibre content of samples during processing/testing: 40-45 vol%

Data calculated for fibre content of 43 vol%

Typical data according to WL 5.3203 Parts 1 and 2 of the GERMAN AVIATION MATERIALS MANUAL

**Measuring Conditions:**

Curing: 24 h at 23 °C (74 °F)

+15 h at 80 °C (180 °F)

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