EPIKOTE™ Resin MGSBPR135G3

EPIKURE™ Curing Agent MGSBPH1340G – 137GF

CHARACTERISTICS

Approval	DNV
Application	Secondary bonding of FRP to FRP and various materials. Production of rotor blades for wind energy plants, shipbuilding, sporting goods, molds, and other devices.
Operational temperature	-40°C up to +70°C after appropriate cure
Processing	In general process temperatures between 10°C – 50°C, depending on individual process conditions.
Features	fills gaps of up to approx. 30 mm without sagging, good sag resistance at elevated temperature
Storage	Shelf life of at least 24 months in originally sealed containers

APPLICATION

Bonding paste EPIKOTE™ MGSBPR135G3 is a solvent free epoxy based bonding paste with a wide range of applications. It is suitable for bonding laminates and wood and appropriately metallic and mineral components.

Bonding Paste Curing Agents

The available bonding paste curing agents show a wide range of processing times (pot life) which allows the selection of a curing agent which fits the processing conditions of interest:
EPIKURE™ Curing Agent MGSBPH1340G very fast
EPIKURE™ Curing Agent MGSBPH1355G fast
EPIKURE™ Curing Agent MGSBPH137GF slow (but fast T_G development)

Paste Application – Sagging / Vertical Gaps

The bonding paste system is particularly suitable for vertical surfaces and wide gaps and is designed not to sag at typical application and cure temperatures. The bonding paste does not bleed out of vertical gaps even if the parts are immediately cured.

Bond lines

Bond line thickness control is important for any structural adhesive joint application to obtain consistent and optimal adhesive joint properties. For larger parts, such as found in boat and wind turbine blade production, bond line thicknesses of 1-10 mm are generally targeted. Due to the glass fiber in the bonding paste system, higher neat mechanical properties and low exothermic temperatures have been observed. In applications where bond line thicknesses may be greater than 10 mm or aggressive cure cycles are used, the effects of higher exothermic temperatures and lower adhesive joint properties should be evaluated.

Mixing

Adding more or less curing agent outside the permissible tolerance range will not speed up or slow down the reaction rate – it will cause incomplete curing of the bonding paste which cannot be corrected in any way by reworking. The resin and curing agent components are thick and must be mixed very thoroughly. Pay special attention to the walls and the bottom of the mixing container.
The different colors of the resin and curing agent components facilitate visual verification. The color is only a visual aid and not precisely specified. Therefore, batch-to-batch variations are possible, especially based on influence of the solid fillers.
Manual mixing of larger quantities of resin and curing agent is very difficult due to the high viscosity of the components. To guarantee good mixing of large volumes in production, the use of suitable mixing machines is essential.

Surface Preparation

Direct application to non-porous material surfaces is possible. Porous, absorbent surfaces should be primed with a liquid resin mix (e.g. laminating resin EPIKOTE™ Resin MGSLR635). The bonding paste can then be applied either immediately or following slight gelling. Independent of surface, priming with bonding paste is not recommended as this can lead to a reduction of adhesion, especially in hot/humid environment.

Applying & Curing

The recommended temperature for mixing and application is around 20 – 30°C. In general, the part surface temperature should be below 35°C during bonding paste application. However, depending on gap thickness and curing agent higher surface temperatures can be possible, but require verification. In any case, detailed processing tests are recommended. All excess bonding paste should be removed from the bond lines before cure.
Parts should be heated at a slow rate (e.g. < 1°C/ minute) to minimize internal stresses during the curing process. For thick bond lines (typically > 10 mm) a stepped cure may be necessary to avoid high temperature peaks due to exothermic reaction of the bonding paste.
In parts with thick bond lines, temperatures in the center of the bonding paste can be measured to help design/ define the cure profile to optimize manufacturing efficiency and bonding paste performance.

General information & Storage

The resins and curing agents can be stored for at least 24 months in the carefully sealed original containers. The products do not crystallize at storage temperatures between 10°C and 30°C.
The resin and curing agents have a different color to facilitate identification of a homogenous mixture. The color is only a visual aid and not precisely specified. Therefore, batch-to-batch variations are possible, especially based on influence of the solid fillers.
The bonding paste contains solid fillers to increase certain performances. It may happen that negligible amounts of visible impurities are within this material. However, these impurities do not affect the overall performance.
Some liquid separation may be observed for the curing agents, which is a natural phenomenon for pastes. In this case, the liquid curing agent without fillers may be visible as a thin film on top of the material. High temperatures and especially extended exposition to higher temperatures will increase the risk to observe this liquid separation and may enlarge the amount of separated liquid. Therefore, storage temperatures above 30°C and direct exposure to sunlight is not recommended. Note, the liquid formation could reach a terminal limit and even in that state, the product retains its overall performance.

The relevant industrial safety regulations for the handling of epoxy resins and curing agents are to be observed.

TYPICAL PROPERTIES

Property	Unit	Resin BPR135G3	Curing agent		
			BPH1340G	BPH1355G	BPH137GF
Color	–	yellow	Blue		
Density[1)]	g/cm³	1,25	1,1		
Viscosity[2)]	Pa·s	60	55	20	15
Pot life[3)]	min		30	45	165
Ultimate T_G[4)]	°C		~ 94	~ 90	

Measuring conditions:
1) measured at 25°C
2) plate-to-plate viscometer, gap 0,5mm, 25°C, shear rate 50 s-1
3) 100g mixture of BPR135G3 and particular curing agent in water bath at 30°C
   Pot life is a standardized lab test under fixed conditions which does not necessarily reflect real process conditions. The usage or working time varies depending on real processing conditions (environmental temperature, lay-up thickness)
4) Fully cured, DSC midpoint, 20K/min

Different local factors like humidity, temperature or mass of the applied material, time of exposure to atmosphere (and others) are directly influencing the material properties, especially processing properties but eventually also mechanical properties. To operate successfully, the production parameters must be determined individually by the user.

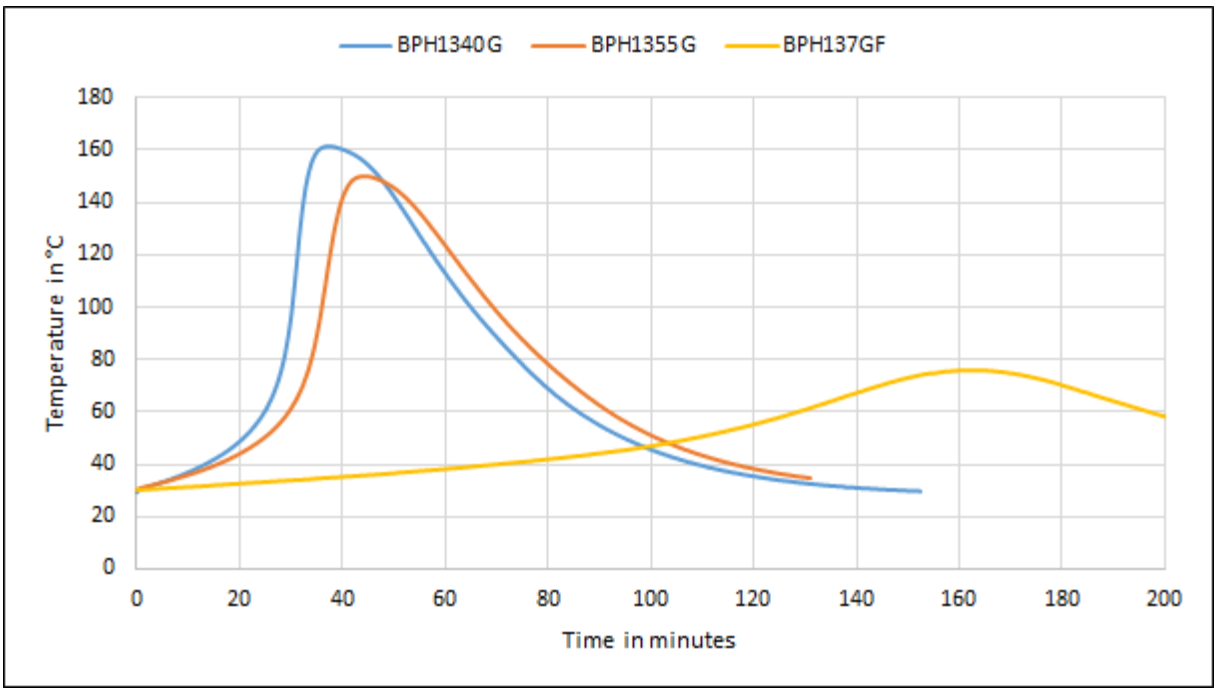
MIXING

Mixing ratio	Parts curing agent per 100 parts resin BPR135G3
Parts by weight	45 ± 2
Parts by volume	50 ± 2

The mixing ratio stated must be observed very carefully. Adding more or less curing agent outside the permissible tolerance range will not speed up or slow down the reaction rate – it will cause incomplete curing of the bonding paste which cannot be corrected in any way by reworking.

The resin and curing agent components are thick and must be mixed very thoroughly. Pay special attention to the walls and the bottom of the mixing container. Manual mixing of larger quantities of resin and curing agent is very difficult due to the high viscosity of the components. To guarantee good mixing of large volumes in production, the use of suitable mixing machines is essential.

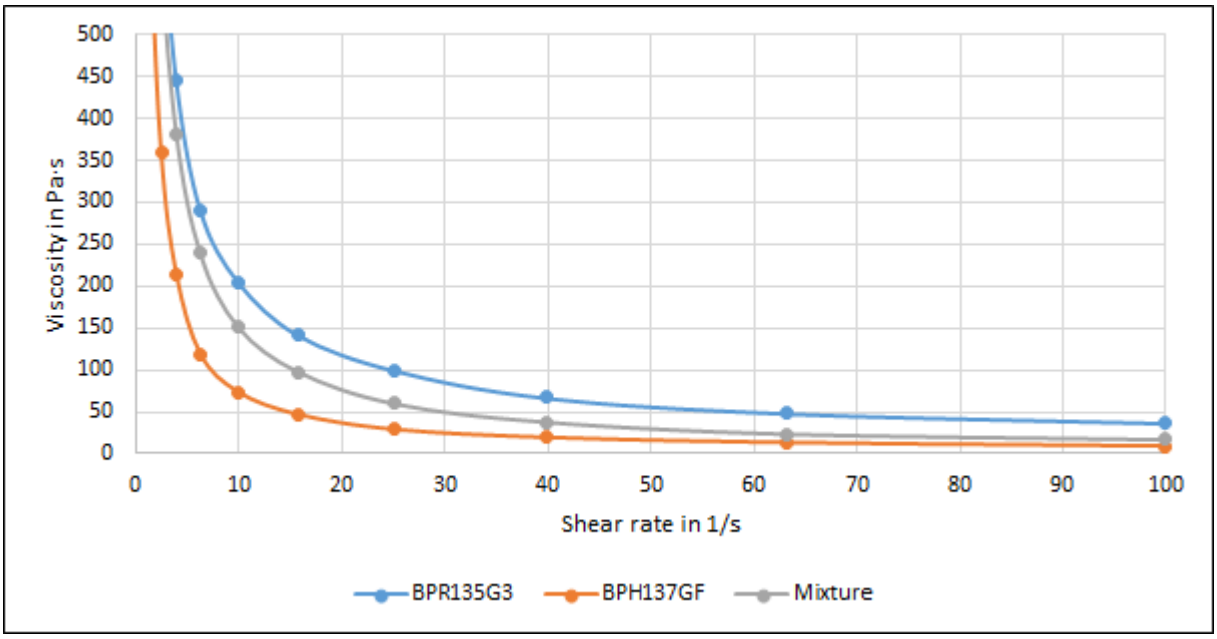
TEMPERATURE DEVELOPMENT



Measuring conditions: 100g of mixture in a water bath at 30°C

The optimum processing (mixing) temperature is in the range of 20°C to 30°C. Higher temperatures are possible but will shorten pot life. As a rule of thumb temperature increase of 10°C will halve the pot life. Do not mix large quantities – particularly of highly reactive systems – at elevated processing temperatures. As the heat dissipation in the mixing container is very slow, the contents will be heated up by the exothermic reaction heat rapidly. This can result in temperatures of more than 200°C in the mixing container, which may cause smoke-intensive burning of the resin mass.

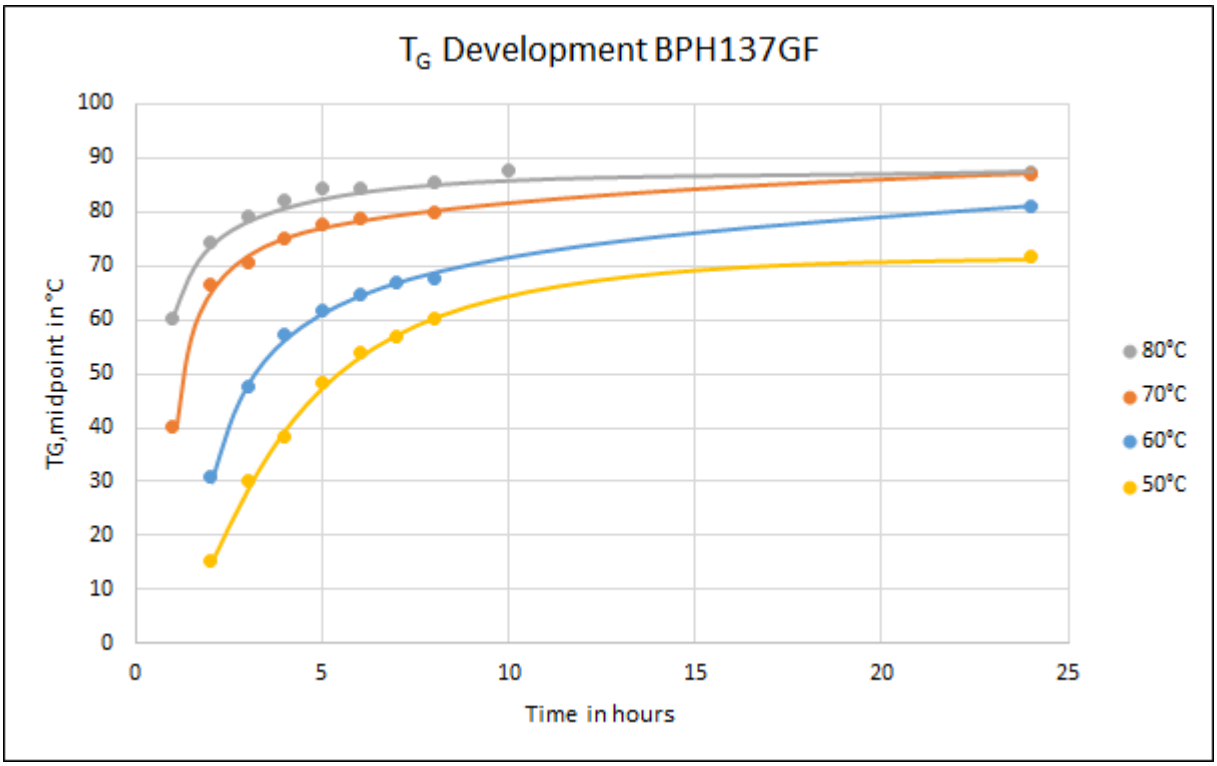
VISCOSITY

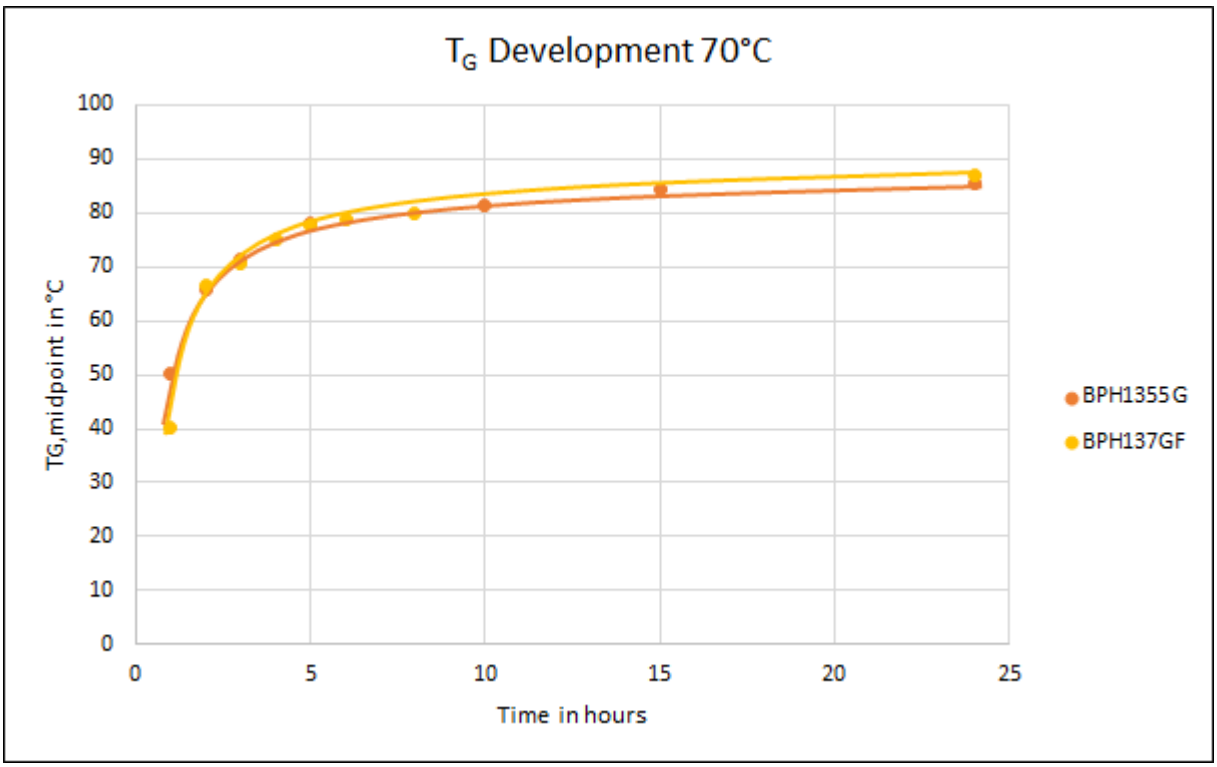


Measuring conditions: Viscometer, variable shear rate, 25°C, plate diameter 25mm, gap 0,5mm

T_G DEVELOPMENT

Measuring conditions: DSC, scan rate 20 K/min





PHYSICAL AND MECHANICAL DATA

Mixed Density, uncured DIN EN ISO 2811-1	**Density [g/cm³]**	1,22	
Mixed density, cured DIN EN ISO 1183-1		1,28	
Single lap shear test[1)] DIN EN ISO 1465	**Bond line [mm]**	0,5	3,0
	Lap Shear Strength[1)] [MPa]	24	15
Peel strength DIN EN ISO 11339	**Peel strength [MPa]**	> 2 N/mm	
Tensile test[2)] DIN EN ISO 527-2	**Tensile strength [MPa]**	70	
	Tensile modulus [GPa]	4,0	
	Tensile strain at break[2)] [%]	2,9	

1) Lap shear Strength strongly depends on specimen configuration, especially laminate thickness
2) Tensile strain at break results strongly depends on specimen quality, especially void content
All data are typical for the combination of BPR135G3 with curing agent BPH137GF at a T_G of approx. 70 – 75°C.
All tests accomplished at standard climate