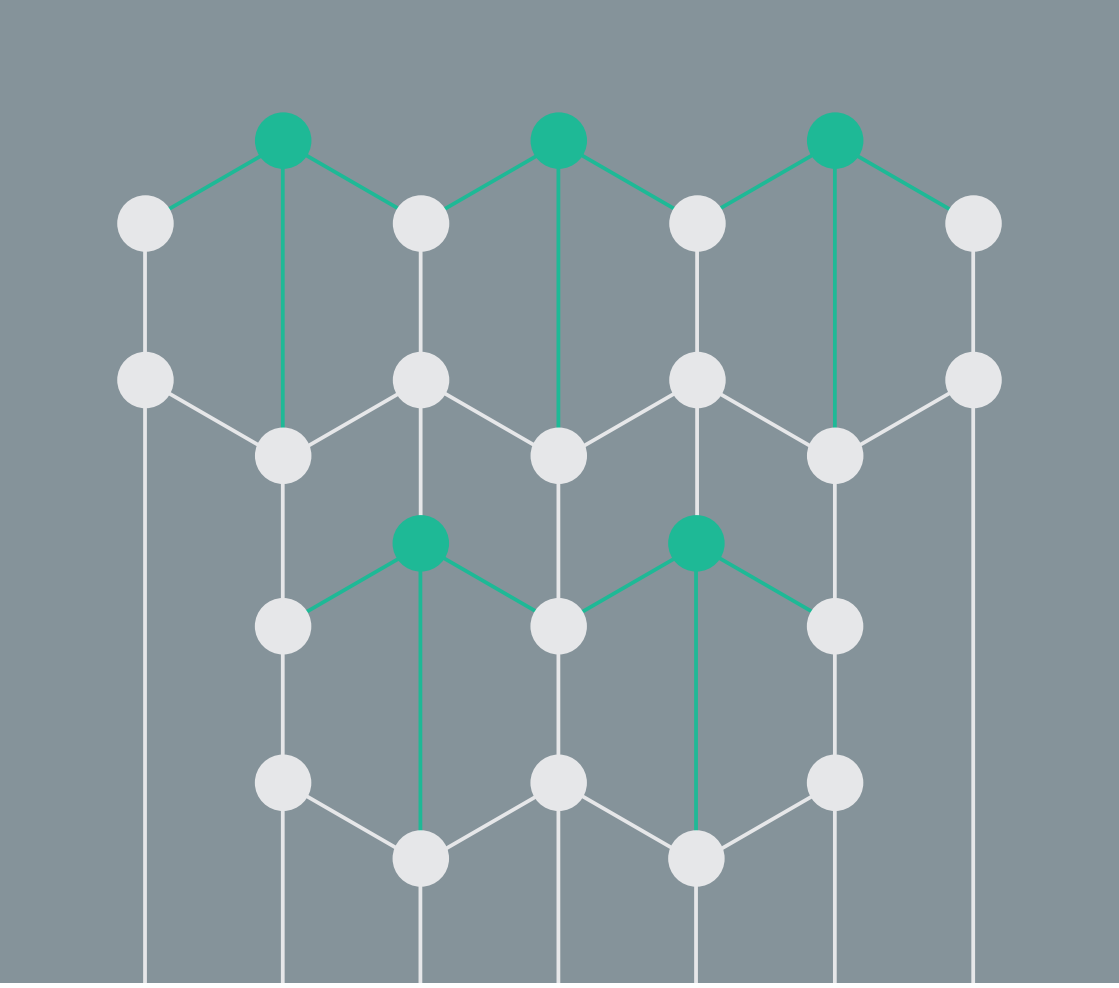


RESINS/CARBON TEXTILE PREPREGS/TOOLING

TECHNICAL INFORMATION

WWW.ITECMA.RU

ITECMA

OUR MISSION IS TO PROVIDE OUR CLIENTS WITH WORLD-CLASS COMPOSITE MATERIALS AND TECHNICAL SUPPORT.

ITECMA

COMPANY

About us

In ITECMA we know that the key points of every composite are the basic characteristics of materials and their processability. To develop and improve our materials, we do two important things every day: we use them ourselves for design and production of final parts, and we carefully listen to our clients. We believe that to achieve extraordinary results, we have to continuously search for the best decision.

Our achievements in composite materials for the aerospace industry of Russia are inspired by the inventions of the professors of Lomonosov Moscow State University's Department of Chemistry.

Since 2003, the private research company Institute of New Carbon Materials and Technologies has been developing a scope of composite materials on the scientific base of MSU, including high quality resins, prepregs and carbon fiber textiles. Production of these materials is carried out at ITECMA capacities.

With a total area of more than 1000 sqm that include research laboratories, a manufacturing site and a testing center, the Institute of New Carbon Materials and Technologies is our solid partner.

Our advantages

1

High-quality resins with operating temperatures ranging from -60 to +350 °C.

2

We develop and create tooling which compensates for warpage distortion in composites.

3

More than 30% of our staff has academic degrees. Among our achievements – more than 150 publications and 50 patents.

4

We have our own production site for fabrics, tapes and prepregs.

5

Materials to produce composites for demanding industries, such as the aerospace industry.

6

We have created an engineering department and a technical support team to help our customers on their facilities.

HEAT-RESISTANT MATERIALS

We developed a line of strong and heat-resistant composites with bismaleimide (BMI) and phthalonitrile (PN) matrices.

These composites have already been successfully used in manufacturing parts for the aerospace industry.

Composite parts with operating temperatures of up to +350°C can be created from phthalonitrile resin and prepreg. The complex combination of the resin characteristics makes it superior to all existing high-temperature alternatives. Moreover, no high-temperature materials and tooling are required for their processing.

The BMI-materials are applied to produce parts with an operating temperature of up to +250°C. At these temperatures, materials have the best combination of mechanical strength and stiffness, high chemical and corrosion resistance, and low CTE.

BMI

PN

Heat-resistant materials

Resin SB332	Resin PN-3M
Prepreg PSB-250	Prepreg PNX-P1
Adhesives KVB-250, KPB-250	

CREATING COMPOSITE TOOLING AND DESIGNING PARTS FROM COMPOSITES

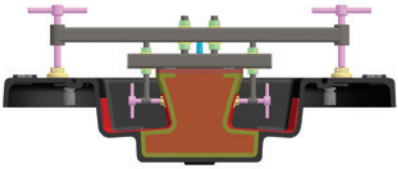
One of our key activities is the development and manufacturing of composite tooling. During the development process, we consider all factors affecting the behavior of tooling in operation.

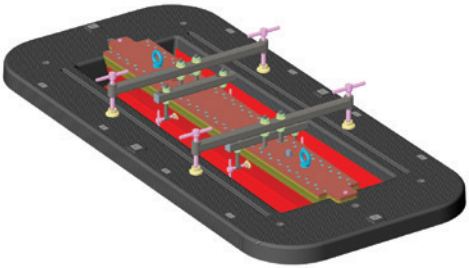
We created a special software for modeling the tooling's geometry with the compensation of warpage distortion, thus allowing us to develop the tooling with an accuracy better than 0.1 mm per 500 mm2.

When faced with the task of making an existing part stronger and lighter, we will redesign the project from metal to composite and perform calculations to make it as lightweight as possible, all while taking into account the special aspects of composite manufacturing.

Composites allow for the creation of structures with anisotropic characteristics. Therefore, the approach to designing parts from CFRP is very different from designing parts made by the casting method and the mechanical operation.

While modeling, we not only take into account the required performance properties of the parts, but also the convenience of the manufacturing process. As such, we simulate the warpage and possible damage during the process of removal from the tooling.





Materials for tooling

TO-29-2	SB322
TO200	

RESINS

Our manufacturing was established during collaboration with aircrafts and spacecrafts producers.

One of the most important characteristics of resin is processability: impregnation temperature, viscosity, pot life and the pre-and post-curing parameters.

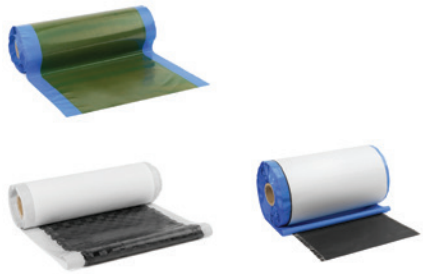
The line of ITECMA resins is well balanced and can therefore be applied in various ways, with different operation temperatures and manufacturing methods (vacuum infusion, RTM, winding).

Our resins, in combination with a competitive price, have one of the best characteristics in their niches and can be used at temperatures ranging from -60 to +350°C.

We are sure that ITECMA resins will perfectly suit your projects.

PREPREGS

Prepregs are made of reinforcement, which is impregnated with a uniformly distributed polymeric resin.



Prepregs are made of reinforcement, which is impregnated with a uniformly distributed polymeric resin.

ITECMA produces high quality prepregs with an operating temperature of up to 350°C and a wide range of applications: sports equipment, primary aerospace structures, high-loaded parts, cars etc.

One of our recent developments is the out-of-autoclave prepreg.

Advantages of out-of-autoclave prepreg molding:

- Doesn't require the autoclave - vacuum bag only;
- Maximum accuracy;
- Small void content;
- Easy to repair;
- Compatibility with less durable, and thus cheaper honeycomb core;
- Production of out-of-autoclave prepreg parts is on average 35% cheaper.

ADHESIVES

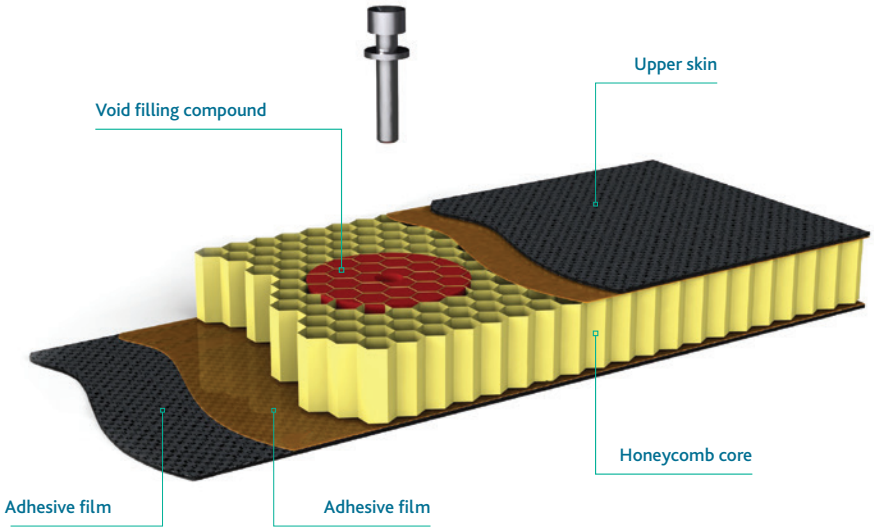
We can offer you various types of adhesives ensuring reliable bonding of joints made of various materials, including composite and metallic.

Some of these adhesives can be operated at temperatures up to +250°C. Our adhesives are optimally suited for filling honeycomb structures in sandwich panels.

A special compound is optimally suited for filling honeycomb structures in sandwich panels.

We produce:

- Thixotropic adhesive;
- Low-temperature adhesive film;
- High-temperature adhesive film;
- High-temperature syntactic paste.



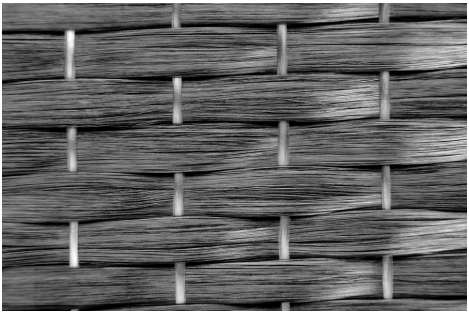
CARBON FABRICS AND TAPES

Today composites follow the trend in additive manufacturing, so we created ROBOLEN – a tape for automated layup. This tape could be used on any standard layup machine.

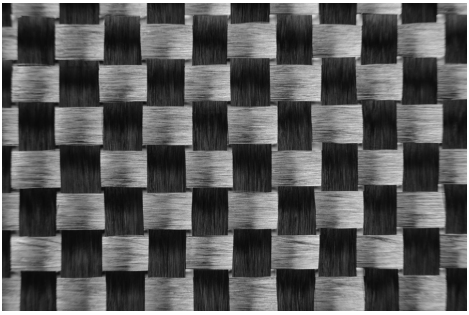
Carbon tapes are used as reinforcement in the manufacturing of composite materials. Compared to steel, aluminium and titanium, carbon fiber is 8-17 times stronger, and its elasticity modulus is 5-13 times higher. Moreover, the CTE of carbon fiber is 15-20 times lower than that of steel and aluminum.

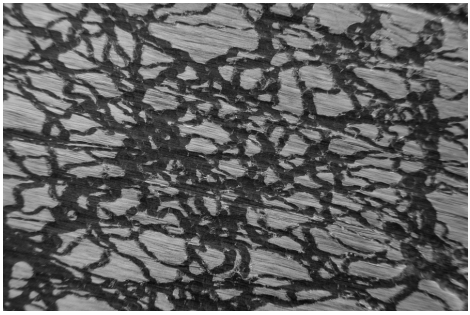
The high thermal stability of carbon fibers allows them to be used as thermal insulators and screens: up to 2000°C in an inert atmosphere and up to 450°C in the air. Carbon fibre's corrosion resistance to gas and liquid media is higher than that of steel.

We can offer tapes and fabrics with binder and veil for increased impact strength. Fabric with a binder layer does not require the usage of temporary fixation glue. We can apply binder to all types of fabrics.

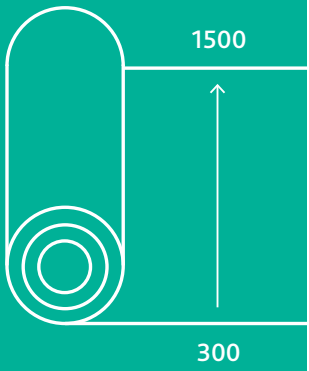


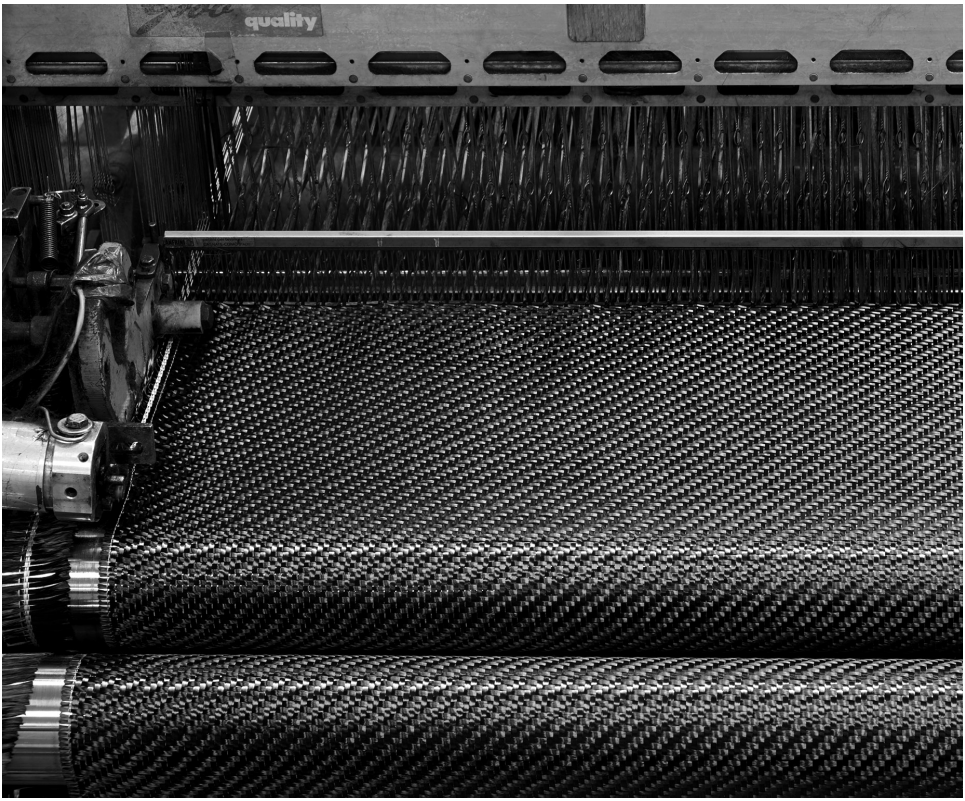
In ITECMA, we have resources and the ability to produce fabrics in accordance with our customers' technical requirements. Our experts will help you find the right material for your project.





ITECMA MANUFACTURES A WIDE RANGE OF CARBON FABRICS AND UNIDIRECTIONAL TAPES BASED ON CARBON FIBER WITH A WIDTH RANGING FROM 300 TO 1500 MM.





PHTHALONITRILE RESIN PN-3M

Technical Data Sheet

PN-3M is a single part phthalonitrile resin with higher glass transition temperature and outstanding thermal stability, specially developed for vacuum infusion and RTM technologies. Pre-curing at 180°C allows to remove parts from tool after cooling. Post-curing provides glass transition temperature above 450°C. Moreover, PN-3M is incombustible. Can be used for high temperature tooling up to 450°C.

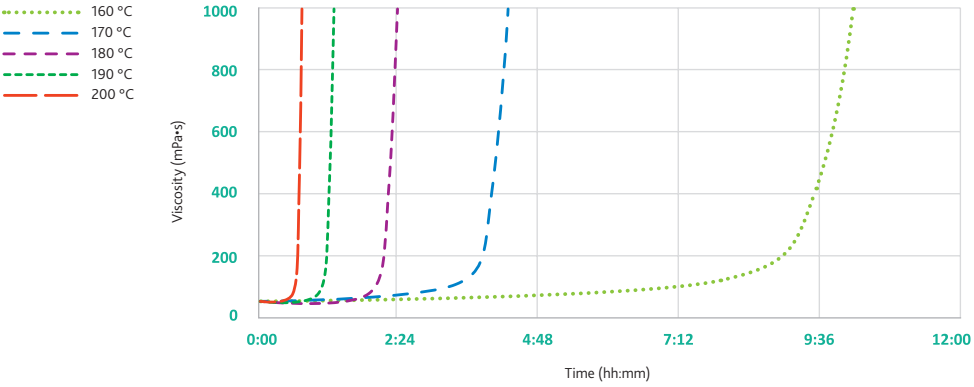
Features & Benefits

- One-part resin system;
- Epoxy-like processability;
- Incombustible (check our test movie);
- Decomposition temperature 520°C;
- Low moisture saturation;
- Low softening temperature 80°C.

Neat resin characteristics

TEST CHARACTERISTIC	STANDARD	CURING T 375°C	180°C
Tensile strength, MPa	ASTM D638	36	60
Tensile modulus, GPa	ASTM D638	4.7	4.8
Flexural strength, MPa	ASTM D790	86	190
Flexural modulus, GPa	ASTM D790	4.5	4.6
Fracture toughness, K_{IC}, MPa·m$^{1/2}$	ASTM D5045	0.562	0.756
Strain energy release, G_{IC}, J/m^2	ASTM D5045	145	276
Dry heat deflection temperature, HDT, °C	ASTM E2092	>450	200
CTE, K^{-1}·10^{-6}	ASTM E831	39	90
Density, g/cm3	ASTM D792	1.347	1.336
Moisture absorption, % (54h boiling water)		3.15	

Viscosity Data



Recommended processing parameters

— Assemble the vacuum bag. Perform a leak test, the rate of the vacuum drop should not be more than 1 mbar per minute. The residual pressure in the bag must not be more than 10 mbar. Assemble the second vacuum bag, put airweave material between the layers of the vacuum film. Perform a leak test for the second vacuum bag. The residual pressure in the bag must not be more than 10 mbar;

— Degas for 30-40 minutes, at 115-125°C, at a pressure of no more than 10 mbar. During the degassing, the resin should be stirred intensively;

— Heat the tool up to 120-130°C. Maintaining the temperature of resin dispenser at 115-125°C, start the infusion process;

— After complete impregnation of the bag, close the resin inputs, but continue evacuation from the inner bag for at least 30 minutes. Then close the outputs from the inner bag. Maintain the outer vacuum bag until the end of curing process;

— Increase the temperature at a rate of 2°C/min to 180°C. Dwell at 180°C for 6 hours;

— Before removing the part, cool the mold to at least 60°C at a speed of no more than 5°C/min;

— Post-cure can be performed without tooling;

— Heat to 180°C at any rate, then heat to 330°C at a rate of 5-10°C/min;

— Dwell at 330°C for 8 hours;

— Cool down the part to 60°C at rate <5°C/min;

— For the measurement of vacuum, the use of absolute pressure sensors is recommended.

Properties of CFRP

Samples for testing were obtained by vacuum infusion based on PN-3M resin and carbon fabric 22502 (twill 2x2, 200 g/m2, 3K, 3.95 GPa).

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength 25°C σ_{11}^{+}, MPa	ASTM D3039	717
Compression strength 25°C σ_{11}^{-}, MPa	ASTM D6641	623
Tensile modulus 25°C E_{11}^{+}, GPa	ASTM D3039	69
Compression modulus 25°C E_{11}^{-}, GPa	ASTM D6641	64
Shear strength τ_{13} , MPa at 25°C	ASTM D2344	36
Shear strength τ_{13} , MPa at 300°C	ASTM D2344	43
Shear strength τ_{13} , MPa at 350°C	ASTM D2344	41
Shear strength τ_{13} , MPa at 400°C	ASTM D2344	38
Shear strength τ_{13} , MPa at 450°C	ASTM D2344	33
Shear strength τ_{12} , MPa, 25 °C	ASTM D3518	85
Shear modulus G_{12}, GPa	ASTM D3518	5.7
Shear strength τ_{12} , MPa, 300 °C	ASTM D3518	75
Shear strength τ_{12} , MPa, 350 °C	ASTM D3518	69
Shear strength τ_{12} , MPa, 400 °C	ASTM D3518	68

Suggested application

— Structures requiring high heat resistance;

— Parts requiring non-combustibility;

— Parts of engines and other special applications;

— High temperature tooling for thermoplastics.

STRUCTURAL BMI RESIN SB332

Technical Data Sheet

SB332 is a one part low viscosity bismaleimide infusion resin developed for high temperature composite parts with service temperature up to 200°C. The resin is characterized by low viscosity at impregnation and molding temperatures (100 cP at 120°C), which makes it possible to obtain CFRP with low porosity. Pre-curing at 190 °C allows to remove composite tool from plastic model. Post-curing at 230°C provides service temperature composite part up to 200°.

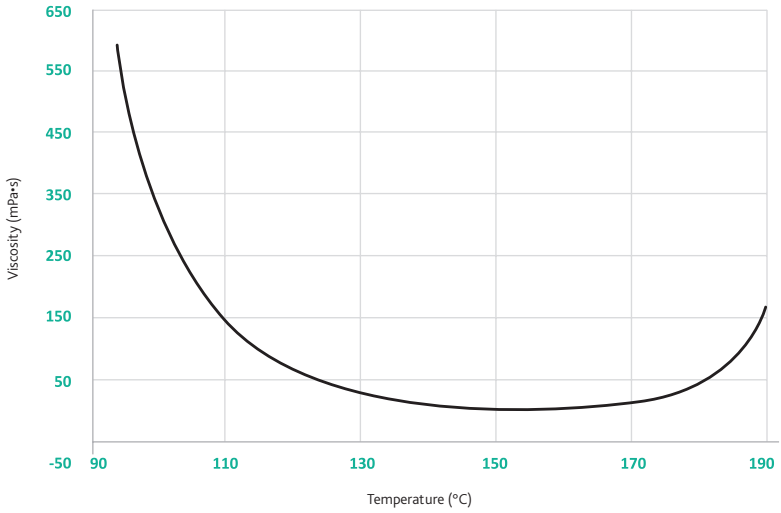
Features & Benefits

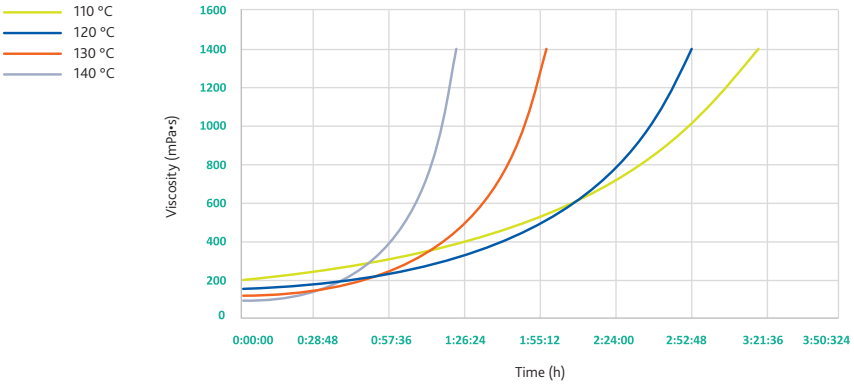
- Wide processing window > 2 hours at 120°C;
- Pre-curing at 190°C;
- Post-curing at 230°C;
- Glass transition temperature 280°C;
- High mechanical performance.

Neat resin characteristics

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength, MPa	ASTM D638	85
Tensile modulus, GPa	ASTM D638	4.4
Flexural strength, MPa	ASTM D790	165
Dry glass transition temperature, Tg, °C	ASTM E1640	280
CTE, K^{-1}	ASTM E831	$51 \cdot 10^{-6}$
Fracture toughness, KIC, $MPa \cdot m^{1/2}$	ASTM D5045	0.841
Strain energy release, GIC, J/m^2	ASTM D5045	194
Moisture absorption, % (60h, boiling water)		4.6

Viscosity Data





Recommended processing parameters

— Assemble the vacuum bag. Perform a leak test, the rate of the vacuum drop should not be more than 1 mbar per minute. The residual pressure in the bag must not be more than 10 mbar. Assemble the second vacuum bag, put airweave material between the layers of the vacuum film. Perform a leak test for the second vacuum bag. The residual pressure in the bag must not be more than 10 mbar;

— Degas for 20-30 minutes, at 100-120°C, at a pressure of no more than 10 mbar. During the degassing the resin should be stirred intensively;

— Heat the tool up to 120-130°C. Maintaining the temperature of resin dispenser at 120°C, start the infusion process;

— After complete impregnation of the bag, close the resin inputs, but continue evacuation from the inner bag for at least 30 minutes. Then close the outputs from the inner bag. Maintain the outer vacuum bag until the end of curing process;

— Increase the temperature at a rate of 2°C/min to 160°C. Dwell at 160°C for 3 hours ; heat to 190°C at a rate of 2°C/min; dwell at 190°C for 3 hours;

— It is possible to heat up to 190°C without exposure at 160°C, in the case that the auxiliary materials and mold materials withstand such conditions;

— Before removing the part, cool the mold to at least 90°C at a speed of no more than 5°C/min;

— Post-cure can be performed without tooling. Heat to 180°C at a rate of 2°C/min, from 180°C to 230° Cheat to 190°C at a rate of 0.5°C/min; dwell 5 hours at 230°C. Do not cool faster than 5°C/min;

— For the measurement of vacuum, the use of absolute pressure sensors is recommended.

Properties of CFRP

Samples for testing were obtained by vacuum infusion based on SB332 resin and carbon fabric (CF) 22508 (sateen 8H, 200 g/m2, 3K, 3.95 GPa).

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength 0° σ_{11}^{+}, MPa	ASTM D3039	853
Compression strength 0° σ_{11}^{-}, MPa	ASTM D6641	797
Tensile modulus 0° E_{11}^{+}, GPa	ASTM D3039	62
Compression modulus 0° E_{11}^{-}, GPa	ASTM D6641	57
Shear strength τ_{13} , MPa	ASTM D2344	84
Shear strength τ_{12} , MPa	ASTM D3518	102

TOOLING RESIN SB322

Technical Data Sheet

SB322 is a one part low viscosity bismaleimide infusion resin developed for high temperature composite tooling with service temperature up to 250°C. The resin is characterized by low viscosity at impregnation and molding temperatures (200 cP at 100 ° C), which makes it possible to obtain CFRP with low porosity. Pre-curing at 190 °C allows to remove composite tool from plastic model. Post-curing at 230°C provides service temperature of tool up to 250°.

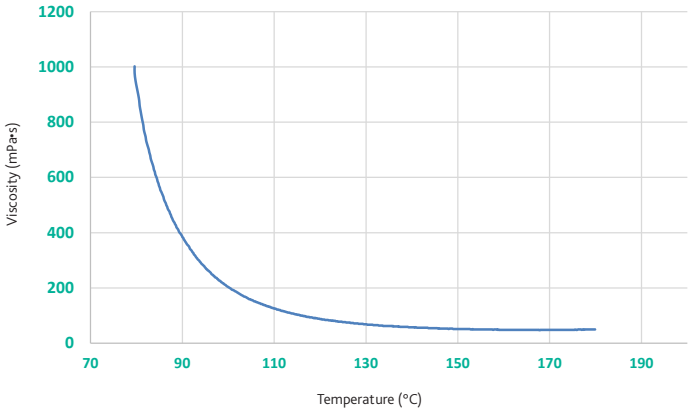
Features & Benefits

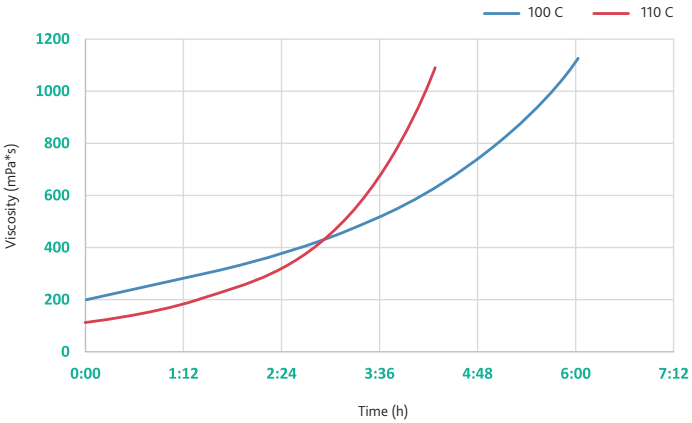
- Wide processing window > 3 hours at 110°C;
- Pre-curing at 190°C;
- Post-curing at 230°C;
- Glass transition temperature 270°C;
- Low Coefficient of Thermal Expansion.

Neat resin characteristics

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength, MPa	ASTM D638	82
Tensile modulus, GPa	ASTM D638	3.9
Dry glass transition temperature, Tg, °C	ASTM E1640	270
CTE, K^{-1}	ASTM E831	$1.5 \cdot 10^{-6}$
Fracture toughness, KIC, $MPa \cdot m^{1/2}$	ASTM D5045	0.780
Strain energy release, GIC, J/m^2	ASTM D5045	165
Moisture absorption, % (60h, boiling water)		4.78

Viscosity Data





Recommended processing parameters

— Assemble the vacuum bag. Perform a leak test, the rate of the vacuum drop should not be more than 1 mbar per minute. The residual pressure in the bag must not be more than 10 mbar. Assemble the second vacuum bag, put airweave material between the layers of the vacuum film. Perform a leak test for the second vacuum bag. The residual pressure in the bag must not be more than 10 mbar;

— Degas for 20-30 minutes, at 100-120°C, at a pressure of no more than 10 mbar. During the degassing, the resin should be stirred intensively;

— It is also recommended to dry the reinforcing material in a vacuum bag for at least 6 hours;

— Heat the mold up to 100-110°C (in case of complex geometry or unidirectional parts, it is possible to increase the temperature of the tooling to 120°C);

— Maintaining the temperature of the mold 100-110°C and the temperature of resin dispenser at 100°C, start the infusion process;

— After complete impregnation of the bag, close the resin inputs, but continue evacuation from the inner bag for at least 30 minutes;

— Close the outputs from the inner bag;

— Maintain the outer vacuum bag until the end of curing process;

— Increase the temperature at a rate of 2°C/min to 160°C. Dwell at 160°C for 3 hours ; heat to 190°C at a rate of 2°C/min; dwell at 190°C for 3 hours;

— It is possible to heat up to 190°C without exposure at 160°C, in the case that the auxiliary materials and mold materials withstand such conditions;

— Before removing the part, cool the mold to at least 90°C at a speed of no more than 5°C/min;

— Post-cure can be performed without mold. Heat to 180°C at a rate of 2°C/min, from 180°C to 230°C heat to 190°C at a rate of 0.5°C/min; dwell 5 hours at 230°C. Do not cool faster than 5°C/min;

— It is recommended to use a quasi-isotropic layouts for tooling. The recommended thickness of the tooling is not less than 5mm. Particular attention should be given to the stiffeners;

— For the measurement of vacuum, the use of absolute pressure sensors is recommended.

TOOLING RESIN TO-29-2

Technical Data Sheet

TO-29-2 is a two part low viscosity epoxy infusion resin developed for high temperature complex shape composite tooling. TO-29-2 offers simple and flexible processing due to low viscosity at low impregnation temperature (25°C). Pre-curing at room temperature allows to remove composite tool from plastic model. Post-curing at 200°C provides service temperature of tool up to 220°. Self-heating time of 500g from 20°C to 60°C is more than 8 hours.

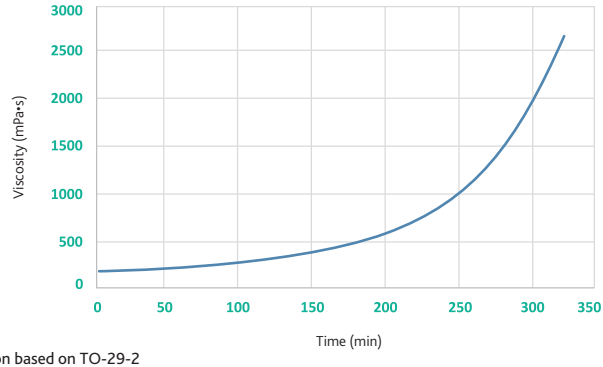
Features & Benefits

- Wide processing window > 4 hours at 25°C;
- Tracking of infusion process under UV light;
- Pre-curing at room temperature;
- Glass transition temperature 220°C;
- Low moisture saturation.

Neat resin characteristics

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength, MPa	ASTM D638	56
Tensile modulus, GPa	ASTM D638	3.6
Dry glass transition temperature, Tg, °C	ASTM E1640	220
CTE, K^{-1}	ASTM E831	$79 \cdot 10^{-6}$
Density of uncured resin, g/cm^3	ASTM D792	1.096
Density of cured resin, g/cm^3	ASTM D792	1.158
Moisture absorption, % (54h, boiling water)		3.22

Viscosity Data



Properties of CFRP

Samples for testing were obtained by vacuum infusion based on TO-29-2 resin and carbon fabrics 22502 (twill 2x2, 200 g/m2, 3K, 3,95 GPa)

TEST CHARACTERISTIC	STANDARD	VALUE
Shear strength τ_{13}, MPa	ASTM D2344	47
CTE in XY direction, K^{-1}, 12K fiber	ASTM E831	$1.8\text{-}2.9 \cdot 10^{-6}$
CTE in XY direction, K^{-1} , 24K fiber	ASTM E831	$1.4\text{-}2.4 \cdot 10^{-6}$

Recommended processing parameters

— Assemble the vacuum bag. Perform a leak test, the rate of the vacuum drop should not be more than 1 mbar per minute. The residual pressure in the bag must not be more than 10 mbar. Assemble the second vacuum bag, put airweave material between the layers of the vacuum film. Perform a leak test for the second vacuum bag. The residual pressure in the bag must not be more than 10 mbar;

— Thoroughly mix components A and B at 25°C in a weight ratio of 100: 58.3. The error in the dosage of components should not exceed 2%. Particular attention should be paid to mixing at the walls and bottom of the mixing tank. It is recommended to use devices with automatic mixing and mix under vacuum;

— Degas for 15-30 minutes, at a pressure of no more than 10 mbar. During the degassing, the resin should be stirred intensively;

— Maintain a temperature of 20-25°C indoors. The recommended impregnation temperature is 25°C. It is also recommended to dry the reinforcing material in a vacuum bag for at least 3 hours;

— Maintaining the temperature of the mold at 20-25°C, start the infusion process;

— After complete impregnation of the bag, close the resin inputs, but continue evacuation from the inner bag for at least 30 minutes;

— Close the outputs from the inner bag;

— Continue evacuation from outer vacuum bag until gelation (~ 24h at 25°C). After 48-72 hours, you can remove tool from the master model and post-cure without auxiliary materials;

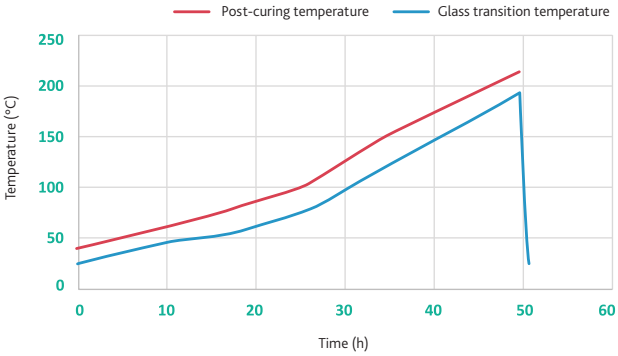
— It is recommended to use a quasi-isotropic layouts for tooling. The recommended thickness of the tooling is not less than 5mm. Particular attention should be given to the stiffeners;

— It is not recommended to mix more than 25kg in same container;

— For the measurement of vacuum, the use of absolute pressure sensors is recommended;

— UV lamp can be used for resin front tracking.

Post-cure:



— Heat up to 70°C at rate < 2°C/hour;

— Heat up to 70 to 190-200 ° C at rate of 5°C/h;

— Hold at 200°C for 1 hour;

— Cool to room temperature no faster than 5°C/min.

TOOLING RESIN TO200

Technical Data Sheet

TO200 is a two-part epoxy resin with unique characteristics, combining high heat resistance, strength and processability. The impregnation temperature is 20-25°C. Flexible curing mode in combination with post-curing allows achieving the required heat resistance at the minimum curing temperature. The resin can be used for manufacturing CFRP or GFRP with sustainable properties up to 120°C, or for composite tooling with service temperatures up to 180 ° C.

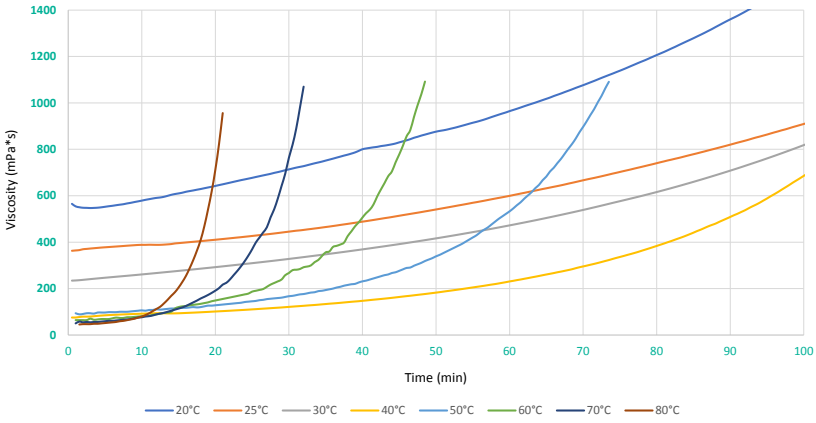
Features & Benefits

- Wide processing window > 2 hours at 25°C;
- Tracking of infusion process under UV light;
- Curing at room temperature;
- Low exotherm;
- High mechanical properties;
- For tooling up to 200°C.

Neat resin characteristics

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength, MPa	ASTM D638	60
Tensile modulus, GPa	ASTM D638	3.26
Flexural strength, MPa	ASTM D790	94
Fracture toughness, K_{IC}, MPa·m$^{1/2}$	ASTM D5045	0.639
Strain energy release, G_{IC}, J/m^2	ASTM D5045	223
Dry glass transition temperature, Tg, °C	ASTM E2092	221
CTE, K^{-1}	ASTM E831	87•10^{-6}
Density, g/cm^3	ASTM D792	1.147

Viscosity Data



Recommended processing parameters

— Thoroughly mix components A and B at 25 ° C in a 1: 0.4388 weight ratio;

— It is recommended to use device with automatic mixing and mix under vacuum;

— Degas the resin with intensive mixing for 15-30 minutes at 20-25 °C, pressure no more than 10 mbar;

— Assemble vacuum bag. Perform a leak test, the rate of the vacuum loss should not be more than 1 mbar per minute. The residual pressure in the bag must not be more than 10 mbar. Assemble the second vacuum bag. Carry out a leak test of the second vacuum bag with same conditions;

— The recommended impregnation temperature is 25°C. It is recommended to preliminarily dry the reinforcing material in a vacuum bag at 60-80°C for at least 1 h or 6 h at 25°C. Maintaining the temperature of the mold at 20-30°C, start the infusion process;

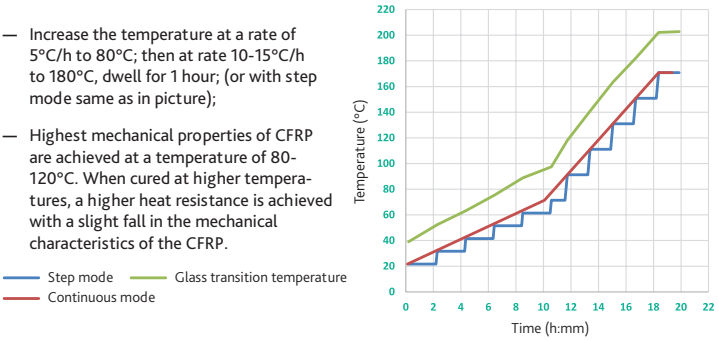
— After complete impregnation, close the resin inputs, continue evacuation from inner bag for at least 30 minutes at 25-40 ° C;

— Close the outputs from the inner bag. Continue evacuation from outer vacuum bag until gelation (~24 h at 25°C). After 48-72 hours, you can remove the part from the mold and post-cure.

Post-cure:

— Increase the temperature at a rate of 5°C/h to 80°C; then at rate 10-15°C/h to 180°C, dwell for 1 hour; (or with step mode same as in picture);

— Highest mechanical properties of CFRP are achieved at a temperature of 80-120°C. When cured at higher temperatures, a higher heat resistance is achieved with a slight fall in the mechanical characteristics of the CFRP.



Properties of CFRP

Samples for testing were obtained by vacuum infusion based on TO200 resin and carbon fabric 22502 (twill 2x2, 200 g/m2, 3K, 3.95 GPa)

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength 0°σ_{11}^{+}, MPa at 25°C	ASTM D3039	814
Tensile modulus 0°E_{11}^{+}, GPa at 25°C	ASTM D3039	61
Compression strength 0° σ_{11}^{-}, MPa at 25°C	ASTM D6641	602
Compression modulus 0° E_{11}^{-}, GPa at 25°C	ASTM D695	59
Shear strength τ_{13} , MPa at 25°C	ASTM D2344	65
Shear strength τ_{13} , MPa at 80°C	ASTM D2344	48
Shear strength τ_{13} , MPa at 120°C	ASTM D2344	34
Shear strength τ_{12} max (5%), MPa at 25°C	ASTM D5379	113(82)
Shear modulus G_{12} , GPa at 25°C	ASTM D5379	3.34

STRUCTURAL EPOXY RESIN T26

Technical Data Sheet

T26 is a single part low viscosity epoxy infusion resin developed for high-loaded structures. T26 offers simple and flexible processing due to low viscosity at relatively low impregnation temperatures (110°C). T26 was developed specially for RTM and vacuum infusion molding, to produce laminates with low porosity and extremely high mechanical performance, especially in crack resistance.

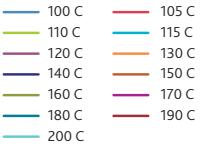
Features & Benefits

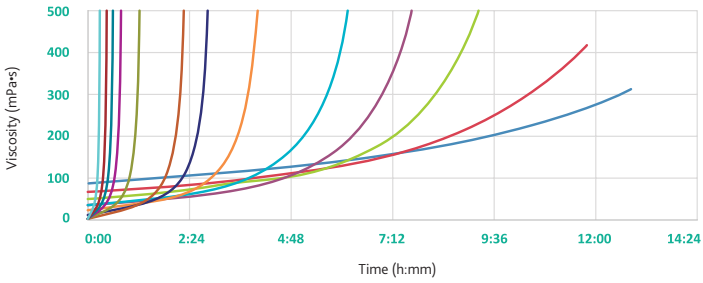
- One-part resin designed specifically for high-temperature infusion or RTM;
- Wide processing window > 7 hours at 110°C;
- Curing at 180°C provides glass transition temperature of 205°C;
- High wet glass transition temperature —172°C;
- Very high resistance to impact;
- Operating temperatures from –60°C to 150°C.

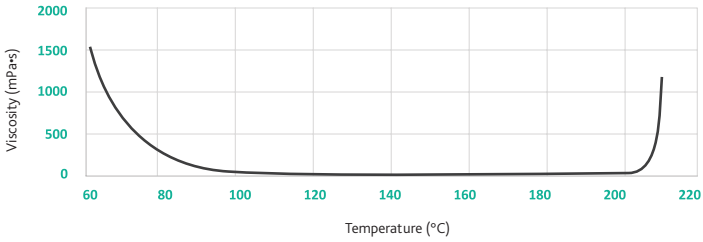
Neat resin characteristics

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength, MPa	ASTM D638	95
Tensile modulus, GPa	ASTM D638	3.1
Elongation at break, %		4-7,2
Flexural strength, MPa	ASTM D790	152
Dry glass transition temperature, Tg, °C	ASTM E1640	202
Fracture toughness, K_{IC}, MPa·$m^{1/2}$	ASTM D5045	0.624
Strain energy release, G_{IC}, J/m^2	ASTM D5045	188
CTE, K^{-1}	ASTM E831	72•10^{-6}
Density, g/cm^3	ASTM D792	1.17
Moisture absorption, % (54h, boiling water)		1.6

Viscosity Data







Recommended processing parameters

— Preheat the resin to 60-90 °C in its container for transfer to the resin pot;

— Degas the resin for 30-40 minutes while heating to 90 °C;

— Preheat the tool to 100-110 °C (or to 115 - 120°C for parts having complex shape or for UD parts);

— Maintaining resin pot temperature of 95 °C and tool temperature of 100-115 °C, begin resin infusion;

— After complete impregnation increase tool temperature at 2°C/min to 180 °C. Dwell at 180 °C for 3 h;

— Cool the tool to 90°C at < 5 °C/min before releasing part from tool.

Properties of CFRP

FABRICS: Samples for testing were obtained by vacuum infusion based on T26 resin and carbon fabric (CF) 22508 (sateen 8H, 200 g/m2, 3K, 3.95 GPa) or plasticized carbon fabric (PCF) 22508 covered by veil.

TEST CHARACTERISTIC	STANDARD	CF	PCF
Tensile strength 0°σ_{11}^{+}, MPa at 25°C	ASTM D3039	910	904
Tensile strength 90°σ_{22}^{+}, MPa at 25°C	ASTM D3039	881	904
Tensile modulus 0°E_{11}^{+}, GPa at 25°C	ASTM D3039	65	66
Tensile modulus 90°E_{22}^{+}, GPa at 25°C	ASTM D3039	66	66
Compression strength 0° σ_{11}^{-}, MPa at 25°C	ASTM D6641	643	638
Compression strength 90° σ_{22}^{-}, GPa at 25°C	ASTM D6641	679	608
Shear strength τ_{13}, MPa at 25°C	ASTM D2344	74	66
Shear strength τ_{13}, MPa at 120°C	ASTM D2344	51	40
Shear strength τ_{13}, MPa at 150°C	ASTM D2344	45	34
Shear strength τ_{12}, MPa at 25°C	ASTM D3518	84	79
Shear modulus G_{12}, GPa at 25°C	ASTM D3518	4.5	4.3
Compression after impact 6.67 J/mm, MPa	ASTM D7137	225	301
Delamination area, mm^2	ASTM D7137	679	483
G_{IC}, kJ/m^2	ASTM D5528	0.4-0.5	0.8-2.8

UD TAPES: Samples for testing were obtained by vacuum infusion based on T26 resin and UD tape covered by veil 11424 (200 g/m2, 12K, 4.5 GPa/240 GPa)

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength 0°σ_{11}^{+}, MPa	ASTM D3039	1886
Compression strength 0° σ_{11}^{-}, MPa at 25°C	ASTM D6641	1210
Compression strength 0° σ_{11}^{-}, MPa at 80°C	ASTM D6641	920
Compression strength 0° σ_{11}^{-}, MPa at 120°C	ASTM D6641	772
Compression strength 0° σ_{11}^{-}, MPa at 150°C	ASTM D6641	691
Tensile strength 90° σ_{22}^{+}, MPa	ASTM D3039	59
Compression strength 90° σ_{22}^{-}, MPa	ASTM D6641	166
Tensile modulus 0° E_{11}^{+}, GPa	ASTM D3039	108
Tensile modulus 90° E_{22}^{+}, GPa	ASTM D3039	7,0
Shear strength τ_{13}, MPa at 25°C	ASTM D2344	69
Shear strength τ_{13}, MPa at 80°C	ASTM D2344	46
Shear strength τ_{13}, MPa at 120°C	ASTM D2344	34
Shear strength τ_{13}, MPa at 150°C	ASTM D2344	28
Shear strength τ_{12}, MPa	ASTM D3518	80
Shear modulus G_{12}, GPa	ASTM D3518	4,0
Compression after impact 6,67J/mm, MPa	ASTM D7137	340

EPOXY RESIN TK123

Technical Data Sheet

TK123 is a two-part low viscosity epoxy infusion resin developed for tooling up to 120°C, or CFRP parts with sustainable properties up to 90°C. The resin offers simple and flexible processing due to low viscosity at room temperature (lower than 500 mPa*s at 25°C). TK123 was developed specially for vacuum infusion molding, to produce laminates with low porosity and good mechanical performance.

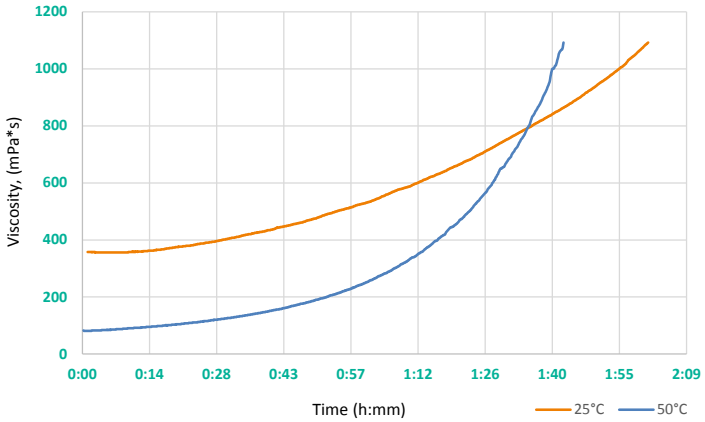
Features & Benefits

- Two-part resin system for vacuum infusion and RTM;
- Wide processing window > 2 hours at 25°C;
- Curing at room temperature;
- High mechanical properties;
- For tooling up to 120°C;
- Low exotherm.

Neat resin characteristics

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength, MPa	ASTM D638	80
Tensile modulus, GPa	ASTM D638	3.56
Flexural strength, MPa	ASTM D790	161
Fracture toughness, K_{IC}, MPa·m$^{1/2}$	ASTM D5045	0.964
Strain energy release, G_{IC}, J/m^2	ASTM D5045	393
Dry glass transition temperature, Tg, °C	ASTM E2092	101
Density, g/cm^3	ASTM D792	1.137

Viscosity Data



Recommended processing parameters

— Thoroughly mix components A and B at 25 ° C in a 1: 0.434 weight ratio. The error in the dosage of components should not exceed 2%. Particular attention should be given to mixing at the walls and bottom of the mixing tank. It is recommended to use devices with automatic mixing and mix under vacuum;

— Degas the resin with intensive mixing for 15-30 minutes at 20-25 °C, pressure no more than 10 mbar;

— Assemble vacuum bag. Perform a leak test, the rate of the vacuum loss should not be more than 1 mbar per minute. The residual pressure in the bag must not be more than 10 mbar. Assemble the second vacuum bag, between the layers of the vacuum film airweave should be laid. Carry out a leak test of the second vacuum bag. The residual pressure in the bag must not be more than 10 mbar;

— Maintain temperature at 25-40°C. The recommended impregnation temperature is 25-35°C. It is recommended to preliminarily dry the reinforcing material in vacuum bag at 60-80 ° C for at least 1 hour;

— Maintaining the temperature of the mold at 25-35°C, start the infusion process;

— After complete impregnation, close the resin inputs, continue evacuation from inner bag for at least 30 minutes at 25-40 ° C;

— Close the outputs from the inner bag. Continue evacuation from outer vacuum bag until gelation (~ 24 h at 25°C). After 48-72 hours, you can remove the part from the mold and post-cure without mold.

Post-cure:

— Increase the temperature at a rate of 2°C/h to 80°C; keep it at 80°C for 6 hours;

— Curing is allowed immediately after the impregnation process without being removed from the mold. Increase the temperature at a rate of 2°C/min to 80°C; exposure at 80°C for 6 hours.

— Before removing the part, cool the tooling to at least 50°C at a speed of no more than 5°C/min.

— Curing (heating rate 2°C/min) or post-curing (heating rate 2°C/h) to 120°C is permissible to obtain a glass transition temperature of 140°C.

Properties of CFRP

Samples for testing were obtained by vacuum infusion based on TK123 resin and carbon fabric 22502 (twill 2x2, 200 g/m2, 3K, 3.95 GPa)

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength 0°σ_{11}^{+}, MPa at 25°C	ASTM D3039	787
Tensile modulus 0°E_{11}^{+}, GPa at 25°C	ASTM D3039	62
Compression strength 0° σ_{11}^{-}, MPa at 25°C	ASTM D6641	564
Compression modulus 0° E_{11}^{-}, GPa at 25°C	ASTM D695	56
Shear strength τ_{13} , MPa at 25°C	ASTM D2344	66
Shear strength τ_{12} , MPa at 25°C	ASTM D5379	79
Shear modulus G_{12} , GPa at 25°C	ASTM D5379	4.3

EPOXY RESIN T20-60

Technical Data Sheet

T20-60 is a two-part low viscosity epoxy infusion resin developed for mass CFRP production. The resin offers simple and flexible processing due to low viscosity and room temperature impregnation. T20-60 was developed specially for vacuum infusion molding, to produce laminates with low porosity and optimal mechanical performance.

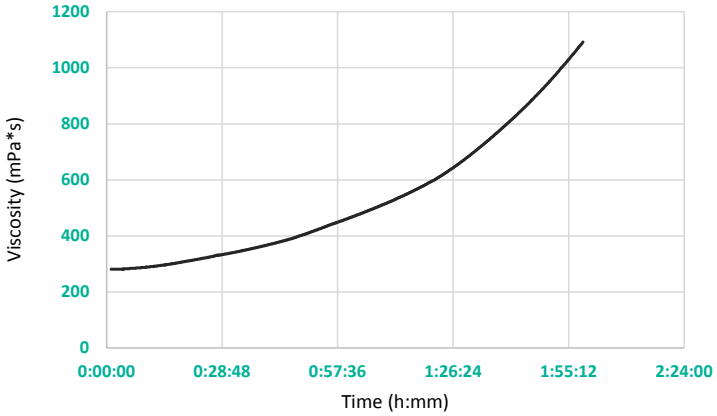
Features & Benefits

- Two-part resin system for vacuum infusion and RTM;
- Wide processing window > 2 hours at 25°C;
- Curing at room temperature;
- Low exotherm;
- High crack resistance;
- Optimal price/quality ratio.

Neat resin characteristics

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength, MPa	ASTM D638	80
Tensile modulus, GPa	ASTM D638	3.2
Flexural strength, MPa	ASTM D790	155
Fracture toughness, K_{IC}, MPa·$m^{1/2}$	ASTM D5045	0.763
Strain energy release, G_{IC}, J/m^2	ASTM D5045	386
Dry glass transition temperature, Tg, °C	ASTM E2092	87
Density, g/cm^3	ASTM D792	1.273

Viscosity Data



Recommended processing parameters

— Mix the components A and B and weight proportion 100:32;

— Degas the resin with intensive mixing for 15-20 minutes at 20-25 °C;

— Maintaining resin pot temperature of 20-25°C and tool temperature of 20-25°C, begin resin infusion;

— Cure at room temperature for 24h;

— Make sure the resin is gelled;

— Remove auxiliary materials;

— Increase temperature at rate 0,5-2°C/min to 80°C;

— Postcure at 80°C for 3-6h.

Properties of CFRP

Samples for testing were obtained by vacuum infusion based on T20-60 resin and carbon fabric 22502 (twill 2x2, 200 g/m2, 3K, 3.95 GPa)

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength 0°σ_{11}^{+}, MPa at 25°C	ASTM D3039	777
Tensile modulus 0°E_{11}^{+}, GPa at 25°C	ASTM D3039	61
Compression strength 0° σ_{11}^{-}, MPa at 25°C	ASTM D6641	583
Compression strength 0° σ_{11}^{-}, MPa at 80°C	ASTM D6641	460
Compression modulus 0° E_{11}^{-}, GPa at 25°C	ASTM D695	61
Compression modulus 0° E_{11}^{+}, GPa at 80°C	ASTM D695	56
Shear strength τ_{13} , MPa at 25°C	ASTM D2344	58
Shear strength τ_{13} , MPa at 80°C	ASTM D2344	36
Shear strength τ_{12} , MPa at 25°C	ASTM D5379	110
Shear strength τ_{12} , MPa at 80°C	ASTM D5379	56
Shear modulus G_{12} , GPa at 25°C	ASTM D5379	4.1
Shear modulus G_{12} , GPa at 80°C	ASTM D5379	2.5

Suggested application

— Wind turbine blades;

— Construction;

— High-pressure cylinders;

— Sports and leisure;

— Design;

— Room temperature tooling.

AUTOCLAVE EPOXY PREPREG T107

Technical Data Sheet

Features & Benefits

- High mechanical performance;
- High resistance to impact and cracking;
- Glass transition temperature 155°C.

Neat resin characteristics

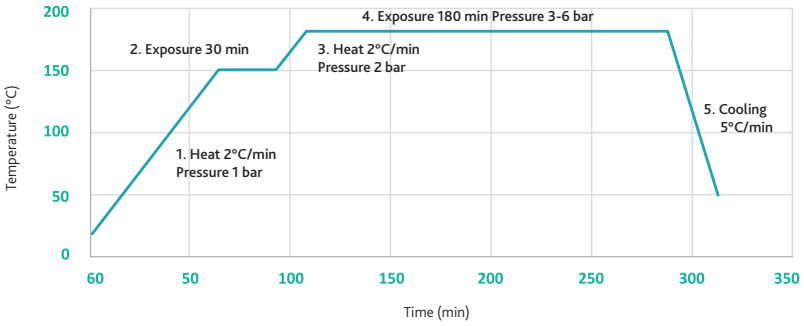
TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength, MPa	ASTM D638	82
Flexural strength, MPa	ASTM D790	189
Fracture toughness, K_{IC}, MPa·m$^{1/2}$	ASTM D5045	2.081
Strain energy release, G_{IC}, J/m^2	ASTM D5045	1455
Dry glass transition temperature, Tg, °C	ASTM D3418	175
Wet glass transition temperature, Tg, °C	ASTM D3418	155
Moisture absorption, % (54h, boiling water)		3.57

Properties of CFRP

Samples for testing were obtained by autoclave formation of prepreg reinforced by carbon fabric 22502 (twill 2x2, 200 g/m2, 3K, 3.95 GPa)

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength 25°C σ_{11}^{+}, MPa	ASTM D3039	904
Compression strength 25°C σ_{11}^{-}, MPa	ASTM D6641	783
Tensile modulus 25°C E_{11}^{+}, GPa	ASTM D3039	62
Compression modulus 25°C E_{11}^{-}, GPa	ASTM D695	62
Compression strength 120°C σ_{11}^{-}, MPa	ASTM D6641	623
Shear strength τ_{13} , MPa at 25°C	ASTM D2344	81
Shear strength τ_{13} , MPa at 90°C	ASTM D2344	73
Shear strength τ_{13} , MPa at 120°C	ASTM D2344	66
Shear strength τ_{13} , MPa at 150°C	ASTM D2344	57
Shear strength τ_{12} (5% / max), MPa, 25 °C	ASTM D5379	106/140
Shear modulus G_{12}, GPa, 25 °C	ASTM D3518	4.9
Compression after impact 6.67 J/mm, MPa	ASTM D7137	260

Recommended processing parameters



OUT-OF-AUTOCLAVE EPOXY PREPREG B180

Technical Data Sheet

Features & Benefits

- High mechanical performance;
- Glass transition temperature 154°C;
- Out of autoclave processing.

Neat resin characteristics

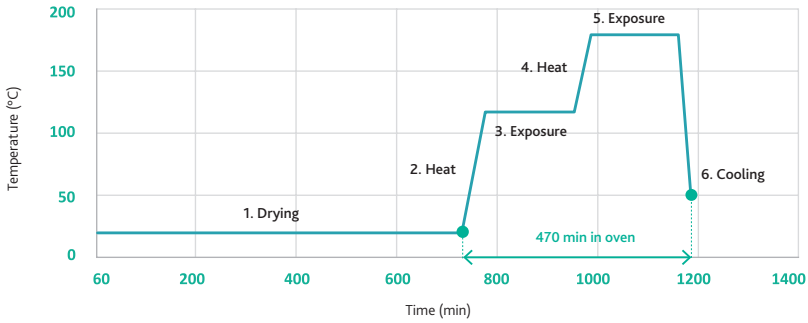
TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength, MPa	ASTM D638	94
Flexural strength, MPa	ASTM D790	162
Fracture toughness, K_{IC}, MPa·m$^{1/2}$	ASTM D5045	1.88
Strain energy release, G_{IC}, J/m^2	ASTM D5045	1340
Dry glass transition temperature, Tg, °C	ASTM E2092	175
Wet glass transition temperature, Tg, °C	ASTM D3418	154
Moisture absorption, % (54h, boiling water)		4.17

Properties of CFRP

Samples for testing were obtained by vacuum formation of prepreg reinforced by carbon fabric 22502 (twill 2x2, 200 g/m2, 3K, 3.95 GPa)

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength 25°C σ_{11}^+, MPa	ASTM D3039	871
Compression strength 25°C σ_{11}^-, MPa	ASTM D6641	802
Tensile modulus 25°C E_{11}^+, GPa	ASTM D3039	71
Compression modulus 25°C E_{11}^-, GPa	ASTM D695	60
Compression strength 25°C $[0,+45]_{ns}$, σ_{11}^-, MPa	ASTM D6641	708
Compression strength 85°C $[0,+45]_{ns}$, σ_{11}^-, MPa	ASTM D6641	639
Tensile strength 25°C $[0,+45]_{ns}$, σ_{11}^+, MPa	ASTM D3039	668
Tensile strength 85°C $[0,+45]_{ns}$, σ_{11}^+, MPa	ASTM D3039	670
Shear strength τ_{12} (5% / max), MPa, 25 °C	ASTM D5379	126
Shear modulus G_{12}, GPa, 25 °C	ASTM D3518	5.7
Shear strength 25°C $[0,+45]_{ns}$, τ_{13}, MPa	ASTM D2344	66
Shear strength 85°C $[0,+45]_{ns}$, τ_{13}, MPa	ASTM D2344	59

Recommended processing parameters



AUTOCLAVE BMI PREPREG PSB250

Technical Data Sheet

Prepreg PSB250 is designed for the production of composite parts or tools operated at temperatures up to 250°C. As a reinforcing material for a prepreg based on the bismaleimide resin PSB250, unidirectional belts and fabrics of various weave can be used.

Features & Benefits

- Glass transition temperature 266 ° C;
- Curing temperature 190 ° C, post-curing 230 ° C;
- High strength and stiffness;
- Good stickiness.

Neat resin characteristics

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength, MPa	ASTM D638	85
Tensile modulus, GPa	ASTM D638	4.4
Flexural strength, MPa	ASTM D790	165
Dry glass transition temperature, Tg, °C	ASTM E1640	280
CTE, K^{-1}	ASTM E831	$51 \cdot 10^{-6}$
Fracture toughness, KIC, $MPa \cdot m^{1/2}$	ASTM D5045	0.841
Strain energy release, GIC, J/m^2	ASTM D5045	194
Moisture absorption, % (60h, boiling water)		4.6

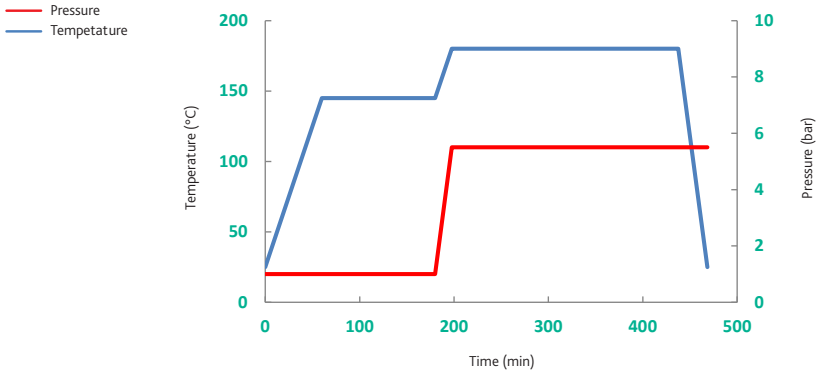
Recommended processing parameters

MOLDING MODE

- Heat 2°C/min to 145 °C, vacuum –1bar, pressure 0 bar;
- Hold at 145 ° C for 120 min, vacuum -1 bar, pressure 0 bar;
- Heat 2 ° C / min to 180 ° C, pressurize 5.5 bar, release vacuum;
- Hold at 180 ° C for 240 minutes, pressure 5.5 bar;
- Cool no faster than 5 ° C / min to 60 ° C, pressure 5.5 bar.

POST-CURING CYCLE:

- Post-cure of the part can be carried out without a tooling;
- Heat at rate 2 ° C / min to 180 ° C;
- Heat no faster than 0.2 ° C / min to 230 ° C;
- Holding at 230 ° C for 300 min;
- Cooling is not faster than 5 ° C / min to 25 ° C.
- To achieve heat resistance up to 250 ° C, additional post-curing is required at 250 ° C for 240 minutes.
- Heat from 230 ° C to 250 ° C at rate 2 ° C / min.



Properties of CFRP

Samples for testing were obtained from prepreg PSB 250 reinforced by carbon fabric 22502 (twill 2x2,200 g/m2, 3K, 3.95 GPa)

TEST CHARACTERISTIC	STANDARD	VALUE
Tensile strength 25°C σ_{11}^{+} 0°, MPa	ASTM D3039	1711
Tensile strength 25°C σ_{22}^{+} 90°, MPa	ASTM D3039	30
Compression strength 25°C σ_{11}^{-} 0°, MPa	ASTM D6641	1071
Compression strength 150°C σ_{11}^{-} 0°, MPa	ASTM D6641	973
Compression strength 180°C σ_{11}^{-} 0°, MPa	ASTM D6641	860
Compression strength 230°C σ_{11}^{-} 0°, MPa	ASTM D6641	810
Compression strength 250°C σ_{11}^{-} 0°, MPa	ASTM D6641	780
Compression strength 25°C σ_{22}^{-} 90°, MPa	ASTM D6641	205
Compression strength 150°C σ_{22}^{-} 90°, MPa	ASTM D6641	158
Compression strength 180°C σ_{22}^{-} 90°, MPa	ASTM D6641	151
Compression strength 250°C σ_{22}^{-} 90°, MPa	ASTM D6641	118
Tensile modulus 25°C E_{11}^{+}0°, GPa	ASTM D3039	137
Tensile modulus 25°C E_{22}^{+}90°, GPa	ASTM D3039	9.5
CAI (6.7 J/mm), MPa	ASTM D7137	149
Shear strength τ_{13} , MPa at 25°C	ASTM D2344	87
Shear strength τ_{13} , MPa at 150°C	ASTM D2344	73
Shear strength τ_{13} , MPa at 180°C	ASTM D2344	70
Shear strength τ_{13} , MPa at 250°C	ASTM D2344	52
Shear strength τ_{12} , MPa, 25 °C	ASTM D3518	72

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HELICOPTERS

RESHETNEV
COMPANY

AeroComposit
Joint Stock Company


ITECMA

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