

# Technical Data Sheet

## Evopreg<sup>®</sup> PFC502

Fire-retardant prepregs with low environmental impact

### Introduction

Evopreg<sup>®</sup> PFC502 prepregs are a range of fire-retardant, pre-impregnated composite materials based on a PFA (Polyfurfuryl Alcohol) bioresin.

PFA is a thermosetting bioresin derived from crop waste and is similar to phenolic resin but with lower toxicity and VOC emissions. In addition to its environmental credentials, PFA has outstanding fire retardant properties, plus excellent temperature and chemical resistance.

The prepregs can be supplied with a range of reinforcement fibres and fabric constructions, including woven and unidirectional E-glass fibre and carbon fibre. They can be consolidated by vacuum bagging, autoclave or press moulding and are designed for applications including aircraft interiors, rail interiors, marine, offshore and construction.

### Key Features & Benefits

- Outstanding FST performance - FAR/CS 25.853 (aero) and EN 45545-2 HL3 (rail)
- Low toxicity and low VOC emissions
- Low environmental impact
- Flexible cure temperature 130-160°C
- Suitable for vacuum bag/oven, autoclave and press moulding
- Suitable for bonding to core materials including Nomex honeycomb
- Service temperature up to 200°C
- Out-life 14 days at room temperature
- Storage life 6 months at -18°C
- Available on a wide range of reinforcement fabrics

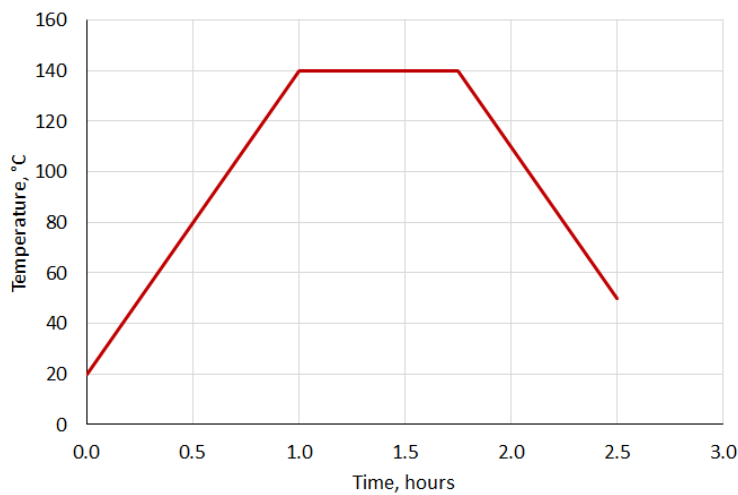
### Processing & Curing

The prepregs can be processed using standard techniques including vacuum bag/oven, autoclave and press moulding. Suggested cure cycles are shown below.

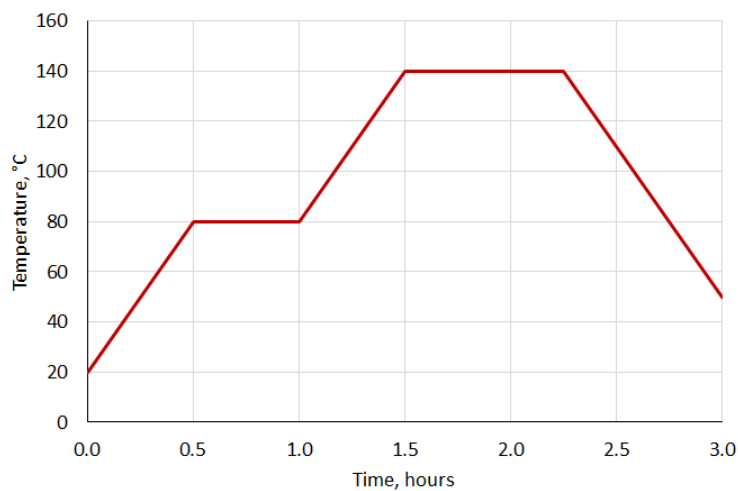
Cure temperature	Minimum cure time
130°C	100 minutes
140°C	45 minutes
150°C	25 minutes
160°C	10 minutes

- Recommended ramp rate 1-3°C/min
- Recommended pressure 3.5 bar (50 psi)
- Cure times may need to be extended to account for thermal lag in large tools

Suggested cure cycle for standard cures at 140°C:

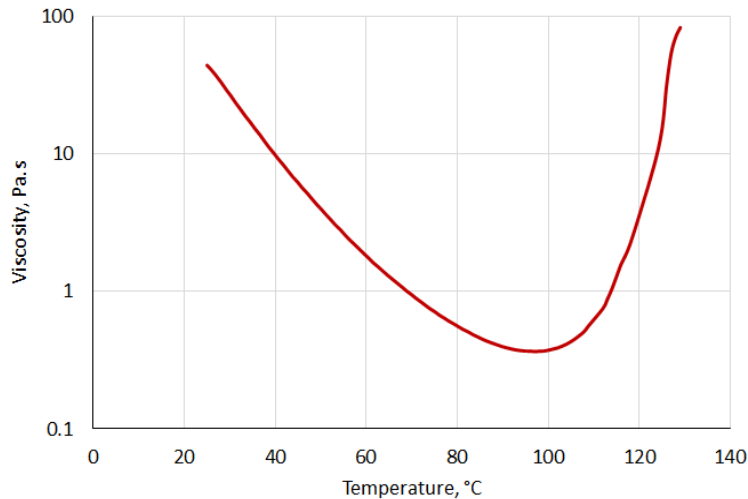


Alternative cure cycle to optimise surface finish for cures at 140°C:



## Viscosity Profile

Plate-on-plate, ambient temperature 25°C, shear rate 20 s<sup>-1</sup>, ramp rate 2°C/min:



## Tooling and Vacuum Bagging Materials

PFC502 prepregs release a small amount of water during cure (polycondensation reaction). It is recommended to use well-sealed and released epoxy composite or stainless steel tooling. Aluminium and carbon steel tools are not recommended, unless coated with PTFE or other impermeable release layer, because the water and pH level can cause corrosion.

When curing in a vacuum bag, it is recommended to use perforated release film and heavyweight breather cloth. For thick laminates, it is recommended to use peel ply and heavyweight breather cloth. It is advisable to use a water/condensation trap to protect vacuum pumps. When press moulding, it may be necessary to take steps to allow the water/steam to escape during the process.

# Composite Properties

## Mechanical Properties of Monolithic Laminates

### Glass

Typical data for laminates made from woven glass-reinforced PFA prepreg (Evopreg® PFC502-G300S-7781-40-1270) cured in an autoclave for 1 hour at 140°C.

Property	Result	Test method
Fibre content by volume, Vf	43%	Internal method
Cured ply thickness	0.26 mm/ply	Internal method
Density	1.84 g/cm <sup>3</sup>	ISO 1183
Flexural strength, 0°	495 MPa	ISO 178
Flexural strength, 90°	395 MPa	ISO 178
Flexural modulus, 0°	21.8 GPa	ISO 178
Flexural modulus, 90°	18.9 GPa	ISO 178
Tensile strength, 0°	304 MPa	ISO 527-4
Tensile strength, 90°	253 MPa	ISO 527-4
Tensile modulus, 0°	21.9 GPa	ISO 527-4
Tensile modulus, 90°	21.1 GPa	ISO 527-4
Compressive strength, 0°	343 MPa	ASTM D3410
Compressive modulus, 0°	22.6 GPa	ASTM D3410
Apparent interlaminar shear strength (ILSS), 0°	41.1 MPa	ISO 14130
In-plane shear strength	85 MPa	ISO 14129
In-plane shear modulus	5.2 GPa	ISO 14129

Typical data for laminates made from woven glass-reinforced PFA prepreg (Evopreg® PFC502-G870T-35-1250) cured in an autoclave at 3.5 bar for 1 hour at 140°C.

<b>Property</b>	<b>Result</b>	<b>Test method</b>
Fibre content by volume, Vf	54%	Internal method
Cured ply thickness	0.64 mm/ply	Internal method
Density	1.93 g/cm <sup>3</sup>	Internal method
Flexural strength, 0°	416 MPa	ISO 14125
Flexural strength, 90°	433 MPa	ISO 14125
Flexural modulus, 0°	20.0 GPa	ISO 14125
Flexural modulus, 90°	21.2 GPa	ISO 14125
Tensile strength, 0°	268 MPa	ISO 527-4
Tensile strength, 90°	246 MPa	ISO 527-4
Tensile modulus, 0°	22.0 GPa	ISO 527-4
Tensile modulus, 90°	22.9 GPa	ISO 527-4
Compressive strength, 0°	158 MPa	ASTM D6641
Compressive strength, 90°	165 MPa	ASTM D6641
Apparent interlaminar shear strength (ILSS), 0°	21.8 MPa	ASTM D2344, failure mode unclear
In-plane shear strength	32.7 MPa	ISO 14129, 8 plies

## Carbon

Typical data for laminates made from woven carbon-reinforced PFA prepreg (Evopreg® PFC502-C245T-HS-3K-42-1250) cured in an autoclave at 3.5 bar for 1 hour at 140°C.

Property	Result	Test method
Fibre content by volume, $V_f$	50%	Internal method
Cured ply thickness	0.28 mm/ply	Internal method
Density	1.47 g/cm <sup>3</sup>	Internal method
Flexural strength, 0°	629 MPa	ISO 14125
Flexural strength, 90°	727 MPa	ISO 14125
Flexural modulus, 0°	49.6 GPa	ISO 14125
Flexural modulus, 90°	45.9 GPa	ISO 14125
Tensile strength, 0°	526 MPa	ISO 527-4
Tensile strength, 90°	619 MPa	ISO 527-4
Tensile modulus, 0°	62.6 GPa	ISO 527-4
Tensile modulus, 90°	55.8 GPa	ISO 527-4
Compressive strength, 0°	294 MPa	ASTM D6641
Compressive strength, 90°	370 MPa	ASTM D6641
Apparent interlaminar shear strength (ILSS), 0°	32.2 MPa	ASTM D2344
In-plane shear strength	61.7 MPa	ISO 14129

Typical data for laminates made from woven carbon-reinforced PFA prepreg (Evopreg® PFC502-C650T-HS-12K-38-1250) cured in an autoclave for 1 hour at 140°C.

Property	Result	Test method
Fibre content by volume, Vf	55%	Internal method
Cured ply thickness	0.65 mm/ply	Internal method
Density	1.57 g/cm <sup>3</sup>	ISO 1183
Flexural strength	454 MPa	ISO 178
Flexural modulus	46.5 GPa	ISO 178
Tensile strength	761 MPa	ISO 527-4
Tensile modulus	61.0 GPa	ISO 527-4
Compressive strength	236 MPa	ASTM D3410
Compressive modulus	56 GPa	ASTM D3410
Apparent interlaminar shear strength (ILSS)	33.9 MPa	ISO 14130
In-plane shear strength	92 MPa	ISO 14129
In-plane shear chord modulus	6.44 GPa	ISO 14129

## Mechanical Properties of Sandwich Panels

Data for sandwich panels with woven glass-reinforced PFA prepreg skins (Evopreg® PFC502-G300S-7781-40, 2 layers, 0.5 mm thick) and Nomex honeycomb core (48 kg/m<sup>3</sup>, 3.2 mm cell, 9.4 mm thick) cured in an autoclave for 1 hour at 140°C. Upperside of fabric (weft face) facing the honeycomb; warp direction of fabric to L-direction of honeycomb.

Property	Result	Test method
Climbing drum peel strength	103 N/75mm	EN 2243-3
Long beam flexural strength	1003 N	SAE 8-266N SAE-AMS-STD-401

## Fire, Smoke & Toxicity Properties

### Aircraft Interiors - FAR/CS 25.853

#### Glass

Typical data for laminates made from woven glass-reinforced PFA prepreg (Evopreg® PFC502-G300S-7781-40, 2 layers, 0.5 mm thick) cured in an autoclave for 1 hour at 140°C.

Property		Test method	Units	Result
Flammability vertical 60 s flaming	Burn length	AITM 2.0002A / FAR/CS 25.853 App.F Pt.I	mm	31
	After flame time		s	<1
	After flame time of drips		s	0 (no drips)
Max. specific optical smoke density within 4 min, flaming mode		AITM 2.0007A / FAR/CS 25.853 App.F Pt.V	-	3
Max. concentration of smoke gas components, flaming mode	HCN	AITM 3.0005 / ABD0031 Iss.F	ppm	0.5
	CO			89
	NO/NO <sub>2</sub>			5.6
	SO <sub>2</sub> /H <sub>2</sub> S			0
	HF			0
	HCl			0
Heat release rate - max. within 5 min (HRR)		AITM 2.0006 / FAR/CS 25.853 App.F Pt.IV	kW/m <sup>2</sup>	28.3
Heat release - within 2 min (HR)			kW.min/m <sup>2</sup>	9.7



## Train Interiors - EN 45545-2

### Glass

Data for laminates made from woven glass-reinforced PFA prepreg (Evopreg® PFC502-G300S-7781-40, 8 layers, 2 mm thick) cured in an autoclave for 1 hour at 140°C.

Requirement set	Test method reference	Parameter	Units	Result average	Class
R1	T02 ISO 5658-2	CFE	kW/m <sup>2</sup>	45.93	HL3
R1, R6	T03.01 ISO 5660-1, 50 kW/m <sup>2</sup>	MARHE	kW/m <sup>2</sup>	32.46	HL3
R1, R6	T10.01 EN ISO 5659-2, 50 kW/m <sup>2</sup>	D <sub>s</sub> 4	-	22.88	HL3
R1, R6	T10.02 EN ISO 5659-2, 50 kW/m <sup>2</sup>	VOF4	min	80.46	HL3
R1, R6	T11.01 EN ISO 5659-2, 50 kW/m <sup>2</sup>	CIT <sub>G</sub> (4 min)	-	0.1536	HL3
		CIT <sub>G</sub> (8 min)	-	0.2555	HL3

### Carbon

Data for laminates made woven carbon fibre-reinforced PFA prepreg (Evopreg® PFC502-C650T-HS-12K-38-1250, 5 layers, 3 mm thick) cured in an autoclave for 1 hour at 140°C.

Requirement set	Test method reference	Parameter	Units	Result average	Class
R1	T02 ISO 5658-2	CFE	kW/m <sup>2</sup>	32.3	HL3
R1, R6	T03.01 ISO 5660-1, 50 kW/m <sup>2</sup>	MARHE	kW/m <sup>2</sup>	43.57	HL3
R1, R6	T10.01 EN ISO 5659-2, 50 kW/m <sup>2</sup>	D <sub>s</sub> 4	-	79.07	HL3
R1, R6	T10.02 EN ISO 5659-2, 50 kW/m <sup>2</sup>	VOF4	min	150.76	HL3
R1, R6	T11.01 EN ISO 5659-2, 50 kW/m <sup>2</sup>	CIT <sub>G</sub> (4 min)	-	0.0874	HL3
		CIT <sub>G</sub> (8 min)	-	0.1771	HL3

## Available Products

Evopreg® PFC502 prepregs are available with a wide range of reinforcements, including woven, non-woven, non-crimp stitched and unidirectional fabrics in the following fibres:

- Glass
- Carbon
- ampliTex™ Flax (non-fire retardant applications)
- Others on request

## Packaging

The material is typically delivered in rolls and with a silicone coated release paper on the bottom and a polythene release film on the top. Typical packaging - 76 mm (3") diameter cardboard core, polythene bag, reusable cable ties, cardboard box and end supports. Where relevant, multiple boxes are typically stacked on a standard wooden pallet, strapped and covered with stretch wrap. Other packaging may be available on request. We recommend retaining the boxed packaging to protect the material during storage.

## Storage

The material should ideally be stored in a freezer at -18°C and sealed in a polythene bag. To protect the material, we recommend storing it in its original box with the end supports. To avoid moisture condensation, allow the material to defrost fully and reach room temperature before opening the polythene bag. Typical thaw time for a full roll is 4-6 hours. Keep the material sealed in a polythene bag when not in use to prevent moisture absorption. Out-life at room temperature is 14 days. Storage life at -18°C is 6 months.

## Health & Safety

Please refer to the Safety Data Sheet (SDS) before use. This material contains resin and fibres which can cause irritation to skin and eyes, and allergic reactions. Wear appropriate PPE including overalls and impervious gloves, and ensure adequate ventilation. Exothermic reactions can occur when curing resins, and particular care must be taken when curing thick laminates.

## Disclaimer

The information provided here is believed to be accurate but should be considered indicative only. It is the responsibility of the customer to check the suitability of the product for their specific application prior to use.

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