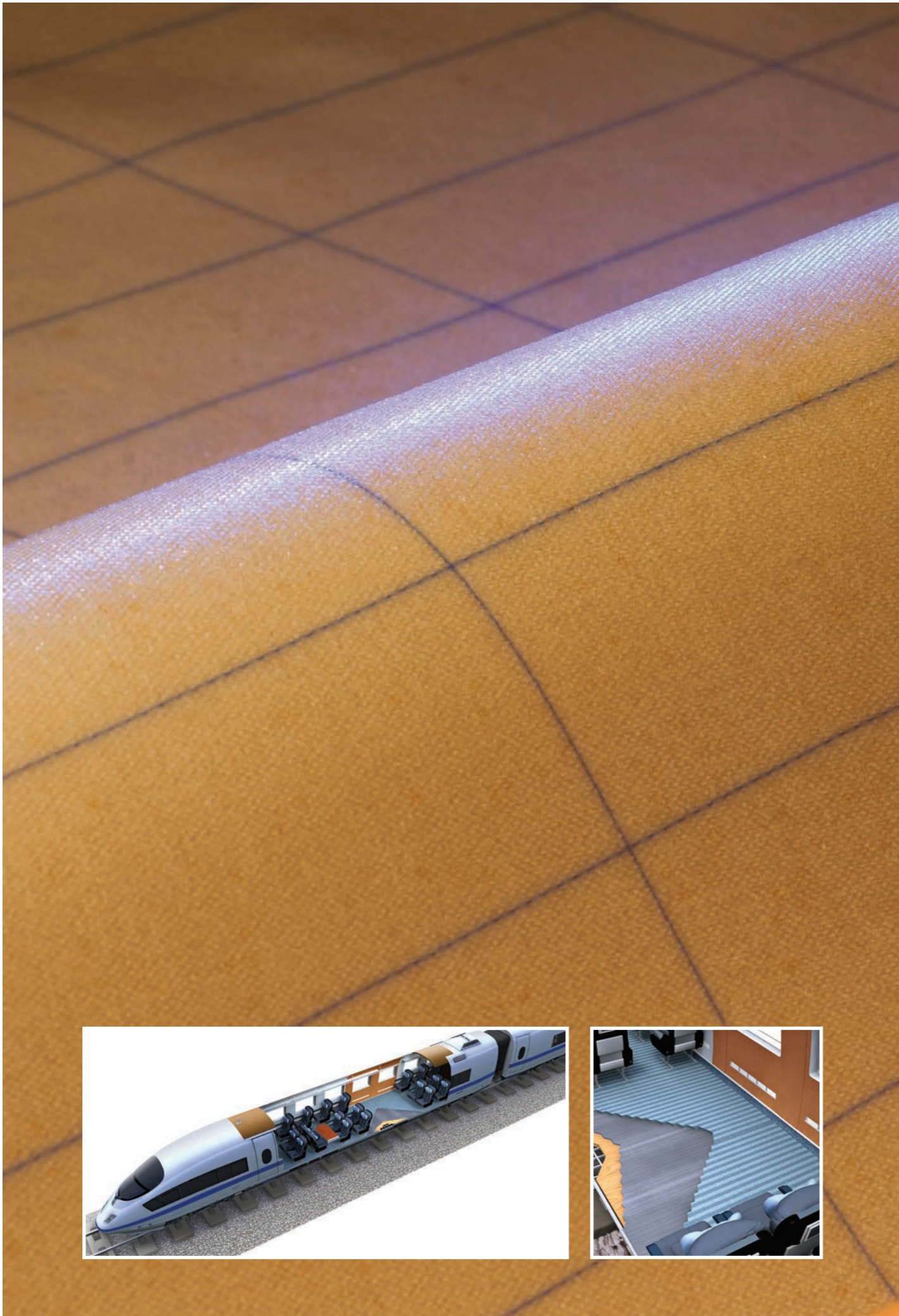


DELIVERING THE FUTURE OF COMPOSITE SOLUTIONS

COMPOSITE MATERIALS FOR RAIL

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ADVANCED COMPOSITE MATERIALS FOR THE RAIL INDUSTRY

As a trusted supplier of composite materials for interior and structural aerospace applications, Gurit has developed a broad range of tried, tested and qualified performance prepreg systems and structural core materials that are ideally suited to manufacture weight-optimised laminate structures, sandwich or crushed-core components that exceed the customers' performance criteria and the most stringent safety requirements of the global rail market.

Gurit prepregs are used in a growing range of rail projects from High-Speed to Subway trains across the globe. From concept to product development and into production, Gurit's experience and understanding ensure products are delivered on time and to specification.

MAXIMUM PASSENGER COMFORT

Sandwich constructions are an ideal way to achieve optimal results and meet passenger requirements. In a sandwich panel, two outer material layers provide a stable and smooth surface, while a lightweight core section adds stiffness and insulation, both ideal for rail applications. Modern rail tracks are designed for speed – the straighter the tracks, the smoother and faster the ride. The topography or cityscape between two destinations is a given and the availability of land is often scarce. Therefore, fast, high-speed, urban train lines feature ever-longer tunnels and bridges, consequently travellers and train crew must be even better protected to get a maximum chance of safely escaping during the unlikely event of an emergency. This is a true call for phenolic prepregs!

MEETING THE MOST STRINGENT SAFETY STANDARDS

Favourable mechanical profiles are important, but chemical features of the material are equally vital, especially in terms of passenger safety requirements. The fire, smoke and toxicity performance (FST) is a top priority when selecting new materials. Gurit's experience in the development of tailored, long-term solutions for the complex aerospace industry has allowed the development and market introduction of Gurit's range of phenolic and epoxy prepregs to the rail market. The outstanding behaviours of Gurit's prepregs include short burn lengths, lowest smoke densities and smoke toxicities and very low heat release values. The range of epoxy and phenolic prepregs and structural core materials now balance high performance, with the most stringent safety requirements for maximum passenger safety, including fire and fumes regulation EN45545.

	TECHNOLOGY	DESCRIPTION	PAGE
PREPREG RESIN CHEMISTRIES	PHENOLIC	Phenolic based chemistry is well established within the aerospace and rail industries where ultimate Fire retardancy, low Smoke emission and low smoke Toxicity (FST) properties are required. Phenolic prepregs are therefore commonly used in interior components such as side walls and flooring.	4
	EPOXY	Gurit has a range of fire-retardant epoxy systems suitable for applications where increased mechanical properties are required. They exhibit good flame spread properties and can be used in components where higher structural performance is required compared to phenolics, such as flooring panels. Where the optimum blend of FST and mechanical properties is required, certain Gurit epoxy prepregs also can be co-cured with phenolic prepregs. This is an established approach to the manufacture of certain flooring sandwich panels.	4-6
STRUCTURAL CORE	PET	Gurit® G-PET™ is a highly adaptable, recyclable, thermoplastic PET (polyethylene-terephthalate) core material with good balance of mechanical properties, temperature resistance, density and cost for a wide range of applications and processes.	7
	BALSA	Gurit® Balsaflex™ is the classic end-grain balsa wood core, featuring very high strength to weight ratio and is available in range of densities, thickness and format/finish. Gurit® Balsaflex™ is approved by Germanischer Lloyd (GL).	7

GURIT'S RANGE OF ADVANCED PREPREGS FOR THE RAIL INDUSTRY

PREPREG PRODUCTS NAMING CONVENTION

- Epoxy Prepreg (SE)
- Epoxy Film Adhesives (SA)
- Fire Retardant (FR)
- Epoxy Surfacing Films (SF)
- Phenolic Prepreg (PH)
- Fire Retardant Obliterated BBlack (FROBL)
- Epoxy SPRINT™ (ST)
- Fire Retardant and Smoke suppressant (FRS)

	PRODUCT NAME	MAIN FEATURES	LOWEST CURE		FASTEST CURE		RECOMMENDED PROCESSING METHOD	MAX T _g BY DMA (°C)	SHELF LIFE		TYPICAL REINF	REINFORCEMENT	FIRE STANDARD	FIRE RATING ACHIEVED		PAGE	
			TEMP (°C)	TIME (HRS)	TEMP (°C)	TIME (MINS)			-18°C (MTHS)	+18°C (DAYS)				BURNING CLASS (S)	SMOKE DEVELOPMENT CLASS (SR)		
PHENOLIC	PH 840	<ul style="list-style-type: none"> → Tested to EN45545 - HL3 Rating in R1 Category → Halogen-free modified phenolic system → Improved vacuum bag processing surface finish → Adjustable tack 	120	1.5	160	15	Vacuum Bag Press Moulding Autoclave	Service temperature up to 160	6	15	→ 300 – 900gm ² woven 0/90° E-Glass	300g Woven E-glass	DIN 5510-2	Burning Class (S)	4	4	
														Smoke Development Class (SR)	2		
														Dripping Class (ST)	2		
													EN45545	HL3 Rating in R1 Category			
													NF F16101	Fire Rating (M)	1		
														Smoke Rating (F)	1		
													UNE 23-727	Fire Rating (M)	1		
EPOXY	ST 70FR	<ul style="list-style-type: none"> → Curable at 70°C in thick sections → Available in SPRINT™ and Prepreg formats → Range of compatible 70°C curing products 	70	16	110	60	Vacuum Bag Press Moulding Autoclave	90	18	14	<ul style="list-style-type: none"> → UD carbon prepreg → Biax / woven E-glass SPRINT™ → Biax / woven carbon SPRINT™ 	600g Woven E-glass	BS476 Part 6	Fire Propagation	I = 11.3 (i1 1.7) (i2 7.3) (i3 2.3)	4	
													Class 1				
												BS476 Part 7	Area Based Toxicity (R)	1.2			
												BS 6853 Annexe B.2	Critical Heat Flux (CFE)	30.07 kW/m ²			
												ISO5658-2	Burning Class (S)	4			
												850g Woven E-glass	DIN 5510-2	Smoke Development Class (SR)	2		
														Dripping Class (ST)	2		
	ISO 4589-2	PN-K-02511:2000	P1														
		UIC Code 564-2 Ap7	A														
EPOXY	ST 120FRS	<ul style="list-style-type: none"> → Tested to EN45545-HL2 Rating in R7 (HL1 in R1) → Curable at temperatures as low as 95°C → 120°C T_g using vacuum bag processing → Excellent tack and drape for easy in-mould repositioning → SPRINT™ enables high quality thick cored laminates to be produced in one operation 	95	16	140	120	Vacuum Bag Press Moulding Autoclave	120	18	21	<ul style="list-style-type: none"> → 300 – 900g/m² Multi-axial Glass → 300 – 600g/m² Multi-axial Carbon 	300g Stitched Biaxial E-glass	ISO5660-1	Maximum Average Rate of Heat Release (MARHE)	60.2 kW/m ²	5	
													Maximum Smoke Value DS (Max)	414			
													Smoke Value at 4 minutes Ds(4.0)	400			
													Total Smoke Release after 4 minutes (VOF4)	1011			
													Smoke Toxicity Index after 4 minutes CITG(4.0)	0.33			
												ISO5659-2	HL2 Rating in R7 Category (HL1 in R1)				
													ISO5658-2	Critical Heat Flux (CFE)	38 kW/m ²		
EPOXY	SE 120FRS	<ul style="list-style-type: none"> → Tested to EN45545-HL2 Rating in R7 (HL1 in R1) → Curable at temperatures as low as 95°C → Can achieve 120°C T_g using vacuum bag processing → Excellent drape for easy in-mould repositioning 	95	16	140	120	Vacuum Bag Press Moulding Autoclave	120	18	21	<ul style="list-style-type: none"> → up to 300g Unidirectional Carbon → up to 300g Unidirectional E-Glass 	300g Unidirectional Carbon	EN45545	HL2 Rating in R7 Category (HL1 in R1)		6	
													ISO5658-2	Critical Heat Flux (CFE)	38 kW/m ²		
													ISO5660-1	Maximum Average Rate of Heat Release (MARHE)	58.5 kW/m ²		
														Maximum Smoke Value DS (Max)	367		
														Smoke Value at 4 minutes Ds(4.0)	362		
EPOXY	SA 120FRS	<ul style="list-style-type: none"> → Provides an effective fire retardant layer using the proven 120FRS resin matrix → Curable at temperatures as low as 95°C → Provides additional resin for core bonding 	95	16	140	120	Vacuum Bag Press Moulding Autoclave	120	18	21	→ 1 x light-weight glass scrim	N/A	See SE 120FRS		6		
EPOXY	SF 120FRS	<ul style="list-style-type: none"> → Provides an effective fire retardant layer using the proven 120FRS resin matrix → Compatible with Epoxy & certain Phenolic prepregs → Curable at temperatures as low as 95°C → Improves de-moulded surface finish 	95	16	140	120	Vacuum Bag Press Moulding Autoclave	120	18	21	→ 2 x light-weight glass scrims	Co-cured with PHG840 600g woven E-glass	ISO5660-1 (indicative only)	Max Average Rate of Heat Release (MAHRE)	37.04 kW/m ²	6	
EPOXY	SF 80FROBL	<ul style="list-style-type: none"> → Provides an effective fire retardant layer → Compatible with Epoxy & certain Phenolic prepregs → With the correct tooling can provide a high gloss black surface finish 	85	10	120	60	Vacuum Bag Autoclave	120	24	14	→ 2 x light-weight glass scrims	Co-cured with PHG840 600g woven E-glass	ISO5660-1 (indicative only)	Max Average Rate of Heat Release (MAHRE)	25.09 kW/m ²	6	

	PRODUCT NAME	MAIN FEATURES	SHEAR			COMPRESSION		DYNAMIC		FST	PROCESSIBILITY					COMPATIBILITY				3RD PARTY CERTS / FIRE CERTIFICATIONS	PAGE	
			STRENGTH	MODULUS	ELONGATION	STRENGTH	MODULUS	IMPACT RESISTANCE	FATIGUE		HEAT STABILITY	HDT	PANEL RESIN UPTAKE	OUT-GASSING	WATER ABSORPTION	MACHINABILITY	VE	PE	EP			PN
PET	Gurit® G-PET™ FR	<ul style="list-style-type: none"> - Recyclable fire retardant foam for civil applications - Also available with 'LITE' surface treatment 	Fair	Fair	Good	Fair	Fair	Fair	Good	Excellent	Excellent	Excellent	Fair	Good	Good	Good	Y	Y	Y	Y	→ Germanischer Lloyd	7
BALSA	Gurit® Balsaflex™	<ul style="list-style-type: none"> - Classic wood core - Available in typical densities & formats - Very high mechanical properties - Sustainably and responsibly sourced 	Outstanding	Outstanding	Fair	Outstanding	Outstanding	Fair	Good	N/A	Outstanding	Outstanding	Fair	Outstanding	Fair	Fair	Y	Y	Y	Y	→ Germanischer Lloyd → Lloyds	7

PH 840

Phenolic Prepreg

Excellent FST properties



Recyclable



High temp processing



- Tested to EN45545 - HL3 Rating in R1 Category (highest rating)
- Excellent mechanical behaviour
- Good surface finish
- Autoclave-free processes possible
- Short curing time 15 min at 160°C / 320°F
- Long shelf and shop life

INTRODUCTION

PH 840 is a halogen-free modified phenolic system, designed for laminate with bright colour and good surface quality.

This prepreg material has been developed for industrial and rail applications with high specific mechanical properties and excellent FST (low heat-release and smoke-density) behaviour.

PH 840 can be cured between 120°C and 160°C (248°F and 320°F). Monolithic and sandwich structures can be easily manufactured with this prepreg. The curing can be performed by press, vacuum and autoclave moulding with a pressure of at least 0.7 bar / 10 psi. Suitable for composite structures experiencing in-service temperatures of -55°C up to +80°C.

TYPICAL APPLICATIONS

PH 840 is ideally suited to rail / industrial / commercial marine craft and automotive applications.



ST 70FR

Fire Retardant SPRINT™

Excellent FST properties



SPRINT™ Technology



70°C cure temperature



- Award winning SPRINT™ matrix
- Self extinguishing
- Suitable for Lloyds and MCA Compliant Structures
- Suitable for monolithic and sandwich structures
- Excellent laminate quality, from vacuum-only processing
- Low smoke toxicity
- Halogen-free

INTRODUCTION

ST 70FR is a fire retardant hot melt, Diuron free epoxy SPRINT™. This is ideally suited to the manufacture of thick sections requiring fire protection. It can be cured at temperatures as low as 70°C, but can also be used for the rapid manufacture of components through its 25-minute cure at 120°C. All of this can be achieved together with an outlife of 14 days at 20°C.

TYPICAL APPLICATIONS

Industrial / commercial marine craft and civil applications where thick fire retardant laminates are required.



ST 120FRS

Low Smoke FR Epoxy SPRINT™

Excellent FST properties



SPRINT™ Technology



95°C cure temperature



- Tested to EN45545 - HL2 Rating in R7 Category (HL1 in R1)
- Curable at temperatures as low as 95°C (203°F)
- Can achieve 120°C Tg using vacuum bag processing
- Excellent tack and drape allowing easy in-mould repositioning
- SPRINT™ enables high quality thick cored laminate production in one operation

INTRODUCTION

The SPRINT™ format makes this product ideal for the manufacture of thick sections requiring a high level of fire protection. It can be cured at temperatures as low as 95°C / 203°F, but can also be used for faster manufacture of components through its 120 minute cure at 140°C / 284°F. ST 120FRS provides high quality laminates from out of autoclave, vacuum only processing.

ST 120FRS has been tested in accordance with the stringent European fire test standard EN45545, achieving a HL2 rating in R7 category (HL1 in R1).

TYPICAL APPLICATIONS

ST 120FRS is ideally suited to rail / industrial / commercial marine craft and civil applications where thick fire retardant laminates are required.

SE 120FRS

Low Smoke FR Epoxy Prepreg

Excellent FST properties



Tested to EN45545



95°C cure temperature



- Tested to EN45545 - HL2 Rating in R7 Category (HL1 in R1)
- Curable at temperatures as low as 95°C (203°F)
- Can achieve 120°C Tg using vacuum bag processing
- Excellent drape allowing easy in-mould repositioning

INTRODUCTION

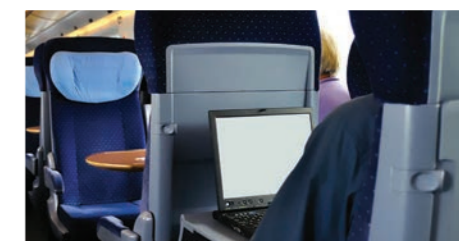
SE 120FRS is a low temperature curing fire retardant & smoke suppressant epoxy prepreg product.

SE 120FRS can be cured at temperatures as low as 95°C / 203°F, but can also be used for faster manufacture of components through its 120 minute cure at 140°C / 284°F. SE 120FRS provides high quality laminates from out of autoclave, vacuum only processing.

SE 120FRS has been tested in accordance with the stringent European fire test standard EN45545, achieving a HL2 rating in R7 category (HL1 in R1).

TYPICAL APPLICATIONS

SE 120FRS is ideally suited to rail / industrial / commercial marine craft and civil applications where thick fire retardant laminates are required.



SA 120FRS

Low Smoke FR Epoxy Resin Film

Excellent FST properties



Ideal for core bonding



- Curable at temperatures as low as 95°C (203°F)
- Can achieve 120°C (248°F) Tg using vacuum bag processing
- Excellent drape allowing easy in-mould repositioning
- Provides additional resin for core bonding

TYPICAL APPLICATIONS

SA 120FRS provides an effective fire retardant layer to be used in conjunction with SE 120FRS / ST 120FRS prepreg / SPRINT™ to produce high quality sandwich laminates from out of autoclave, vacuum only processing.

SF 120FRS

Low Smoke FR Epoxy Surface Film

Excellent FST properties



Compatible with PH 840 Phenolic



Surface film to generate a resin rich surface



- Provides an effective fire retardant layer using the proven 120FRS resin matrix
- Compatible with Epoxy & certain Phenolic prepreps
- Curable at temperatures as low as 95°C (203°F)
- Improves de-moulded surface finish
- Can achieve 120°C (248°F) Tg using vacuum bag processing
- Excellent drape allowing easy in-mould repositioning

TYPICAL APPLICATIONS

SF 120FRS provides an effective fire retardant layer to be used in conjunction with SE 120FRS / ST 120FRS prepreg / SPRINT™ to improve the surface finish direct from out of autoclave, vacuum only processing.

SF 80FROBL

Fire Retardant Surfacing Film

Excellent FST properties



Surface film to generate a resin rich surface



85°C cure temperature



- Provides an effective fire retarding layer to epoxy substrates
- With the correct tooling can provide a high gloss black surface finish
- Resistant to moisture ingress

INTRODUCTION

SF 80FROBL surfacing material is a Fire Retardant Obliterated Black (FROBL), filled epoxy film. It provides an effective fire retarding layer capable of withstanding exposure to fire, while preventing the epoxy substrate from combustion.

SF 80FROBL can be used directly against a suitably release treated mould surface, with prepreg or SPRINT™ plies laid up behind it, or as a final layer in the mould. The product is sufficiently tacky to aid placement into vertical surfaces of a mould. SF 80FROBL can be cured with vacuum only processing.

The epoxy system is supplied ready impregnated into a supporting medium and ready catalysed, requiring only a moderate temperature cure.

TYPICAL APPLICATIONS

Typical applications include protection of structural components in high risk areas such as engine bays, exhaust runs, and around the fuel system.

G-PET™ FR

Fire Retardant Structural Core

Excellent FST properties



Recyclable



High temp processing



- Excellent FST performance (Evaluated against DIN 5510, ASTM E1354, ASTM E662 & BSS 7239)
- Withstands high process temperatures
- Good adhesion & mechanical properties
- Compatible with all composite processes
- Excellent chemical resistance
- Recyclable
- Available with G-PET™ LITE technology

INTRODUCTION

G-PET™ 75FR and G-PET™ 100FR have been developed in order to meet the growing need for structural core materials with good Fire, Smoke and Toxicity (FST) properties used in Marine, Civil and Transportation markets. It offers a much lower cost FST material compared to high cost / high performance materials such as PMI, PEI, PES foams, addressing lower requirements and needs.

Starting with G-PET™ which Gurit's extruded structural PET core, flame retardant additives are added to improve FST properties. The manufacturing process remains the same as G-PET™, with slight variation in process settings. The material is available in all standard knife cut finishes as well as the new surface heat treatment technology G-PET™ LITE.

TYPICAL APPLICATIONS

G-PET™ can be processed at high temperatures, withstanding exotherms up to 150°C / 300°F and offers outstanding fatigue properties, chemical resistance, good adhesion, is a highly consistent extruded foam, it is ideal for wind energy, marine, industrial, and transportation applications. Applicable processing techniques include vacuum infusion, bonding, prepreg, and thermoforming.

Available in a wide range of thickness and finishes.



Gurit® Balsaflex™

Classic Wood Core

Natural and Sustainable



GL certified



High strength to weight ratio



- High quality composite core material made from end grain balsa
- Highest strength to weight ratio of any structural core
- Natural, sustainable and responsibly sourced

INTRODUCTION

Gurit® Balsaflex™ is the classic end-grain balsa wood core, featuring very high strength to weight ratio. When an application requires high-strength and stiffness and cost effectiveness, Gurit® Balsaflex™ is a suitable solution due to a good balance between cost, properties and weight. Gurit® Balsaflex™ is available in a range of densities, thicknesses, formats and finishes. Gurit® Balsaflex™ is GL and Lloyds approved.

TYPICAL APPLICATIONS

Gurit® Balsaflex™ is used for wind turbine blades and nacelles, marine, automotive, truck, rail and aircraft parts. Gurit® Balsaflex™ can be supplied in sheet form or kit-cut to customer's desired shapes.

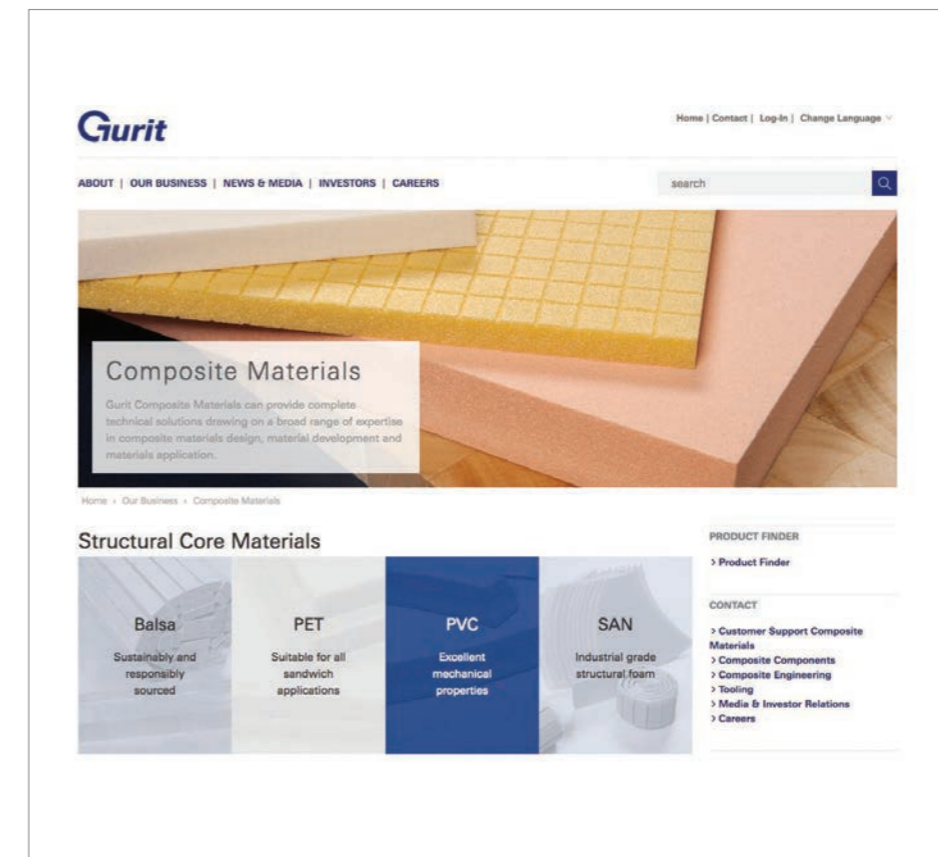


TECHNICAL INFORMATION AND PRICING

For more detailed information on aerospace grade prepregs, as well as the complete Gurit product portfolio, please visit: www.gurit.com to view the following:

- Product Data Sheets
- News / Case Studies
- Events Schedules
- Product Brochures
- Corporate Videos
- Composite Guides
- Representatives Contact Details

For pricing or other enquiries, please contact gurit@gurit.com



www.gurit.com



Product Datasheets



Case Studies

