

Adding Value to Pultrusion Through Improved Surface Functionality with Advanced Nonwoven Veils

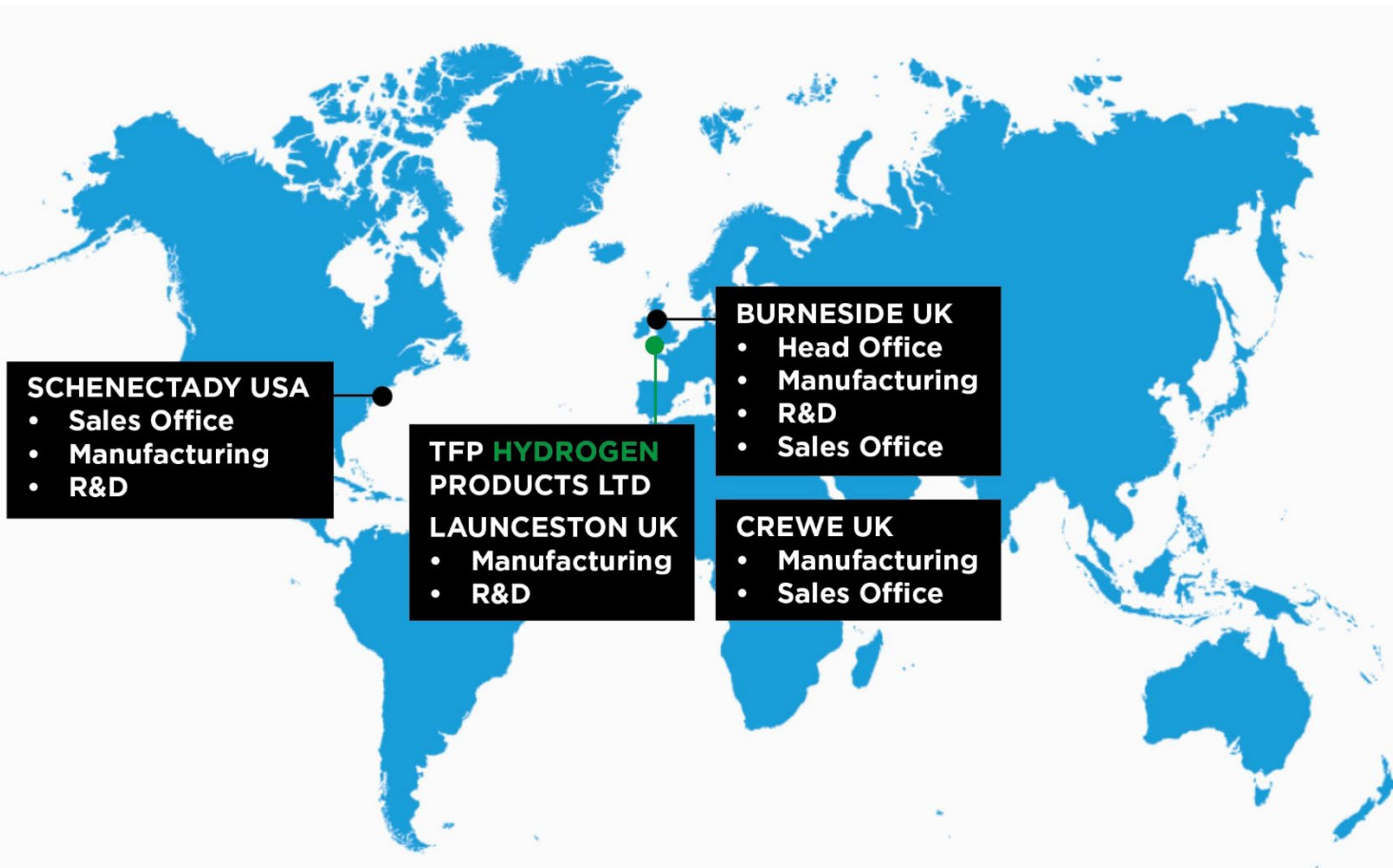
Neil Gray, Business Development Manager

Technical Fibre Products

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 - **Conductivity**
 - **Fire, Smoke & Toxic (FST) fume performance**
- **Key advantages**
- **Summary**

Company Profile - TFP



- **Leading manufacturer of technical nonwovens & electrochemical materials**
- **Supply into aerospace, fuel cell, defence and water electrolyser markets**
- **Extensive converting capability including nanocoating & lamination**
- **4 manufacturing & converting sites**
- **AS9100, ISO 9001 & ISO14001 certified**
- **Part of James Cropper PLC**
 - 595 employees worldwide
 - Listed on the London Stock Exchange

Our Materials

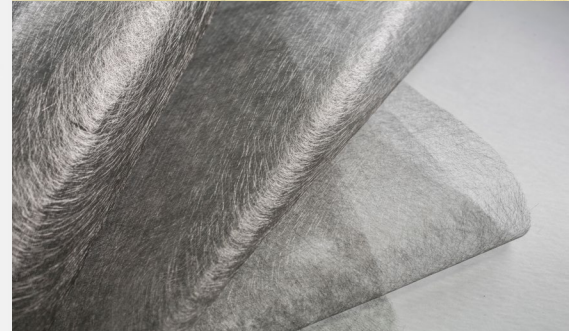
A nonwoven is a highly porous fibre sheet with tuneable properties

Our nonwoven veils and mats are composed of:

- Short chopped engineered fibres
- Dispersed uniformly
- Held together with an organic polymer binder

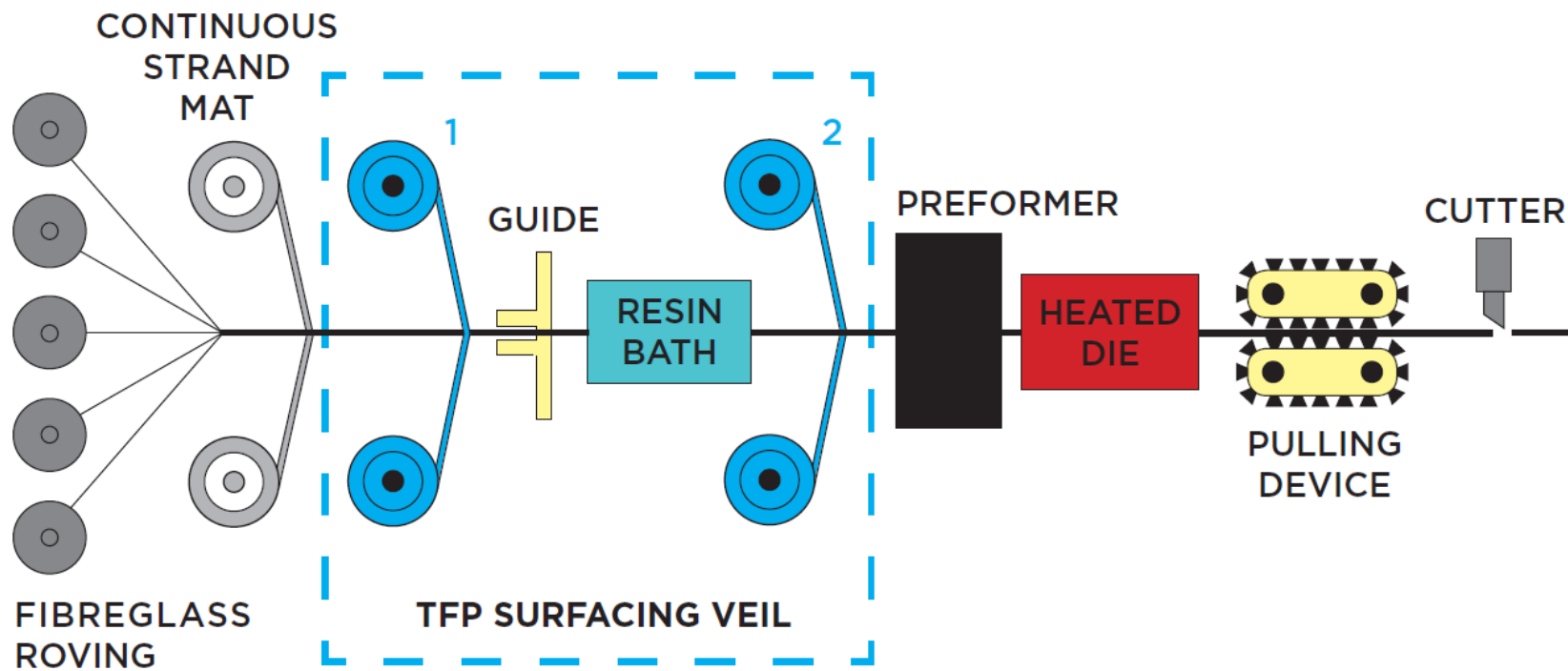
Fibre type dictates properties, typical examples are:

- Carbon, glass, aramid, polyester, metal-coated carbon and thermoplastics



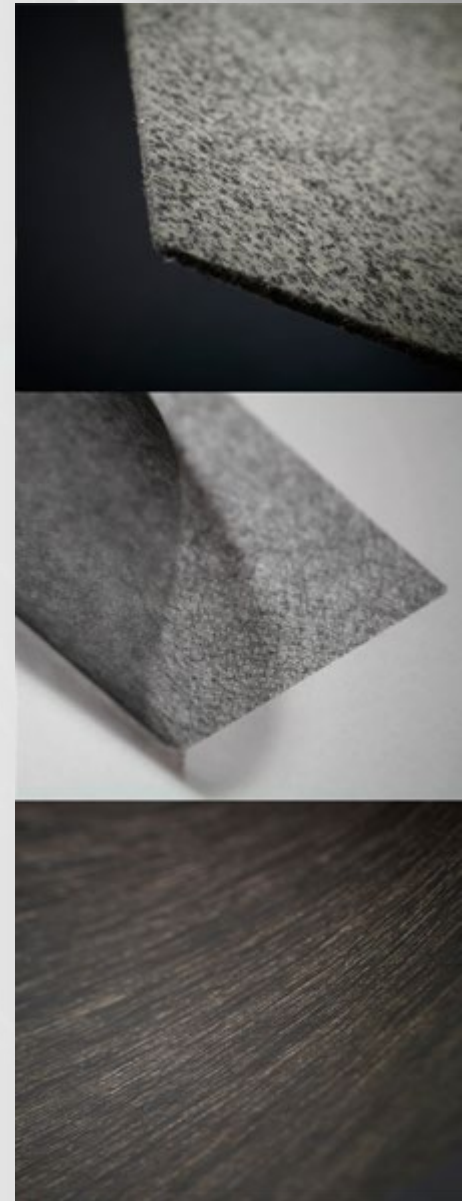
Nonwovens for Pultrusion

- TFP's nonwovens are widely used as a surfacing veil or fire protection layer in pultruded composites.



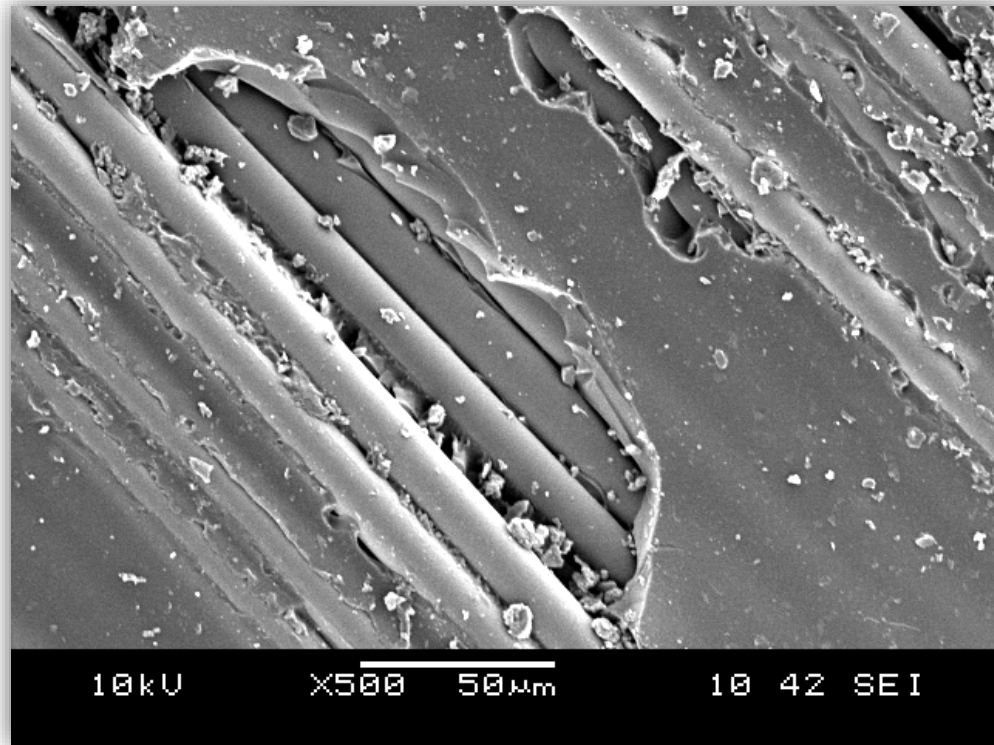
Nonwovens for Pultrusion

- TFP's surfacing veils are compatible with a wide range of resins, including epoxy, vinyl ester, polyester, urethane acrylate, phenolic etc
- They offer both a high wet tensile strength and good dimensional stability
- Veils are incorporated prior to passing through the heated die and provide a resin rich layer on the surface of the part
- Type of veil chosen to impart additional surface functionality to the composite profile
 - **Glass & Polyester** – Enhanced corrosion resistance
 - **Carbon & Metal Coated Carbon** - Conductivity for static dissipation
 - **Aramid** - Improved abrasion resistance
 - **Tecnofire** - Improved fire, smoke and toxic fume (FST) performance

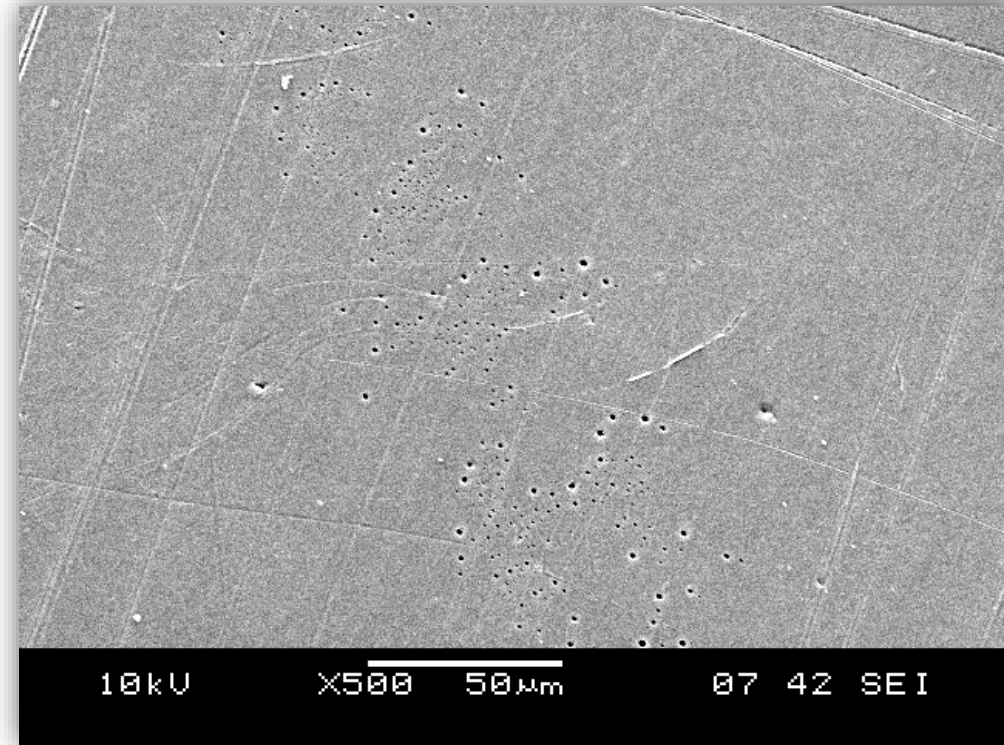


Improving Surface Finish in Composites

A surfacing veil provides a high quality resin rich surface finish to a composite:



Without Surfacing Veil



With 6 g/m² Fine Polyester Veil

Improving Surface Finish in Composites

KEY BENEFITS:

- Reduced incidence of fibre breakout and bleed through
- Minimises print through from underlying reinforcement
- Reduced re-work, such as sanding and painting

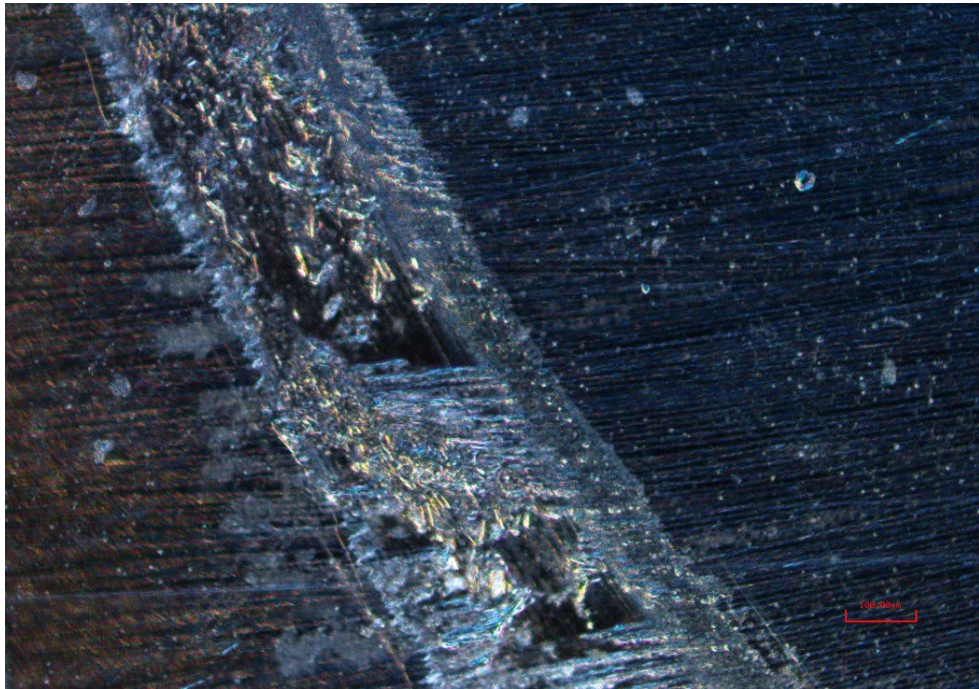
APPLICATIONS:

- Commercial aircraft interior & exterior finish
- Class A in automotive
- Wind turbines
- Sporting goods

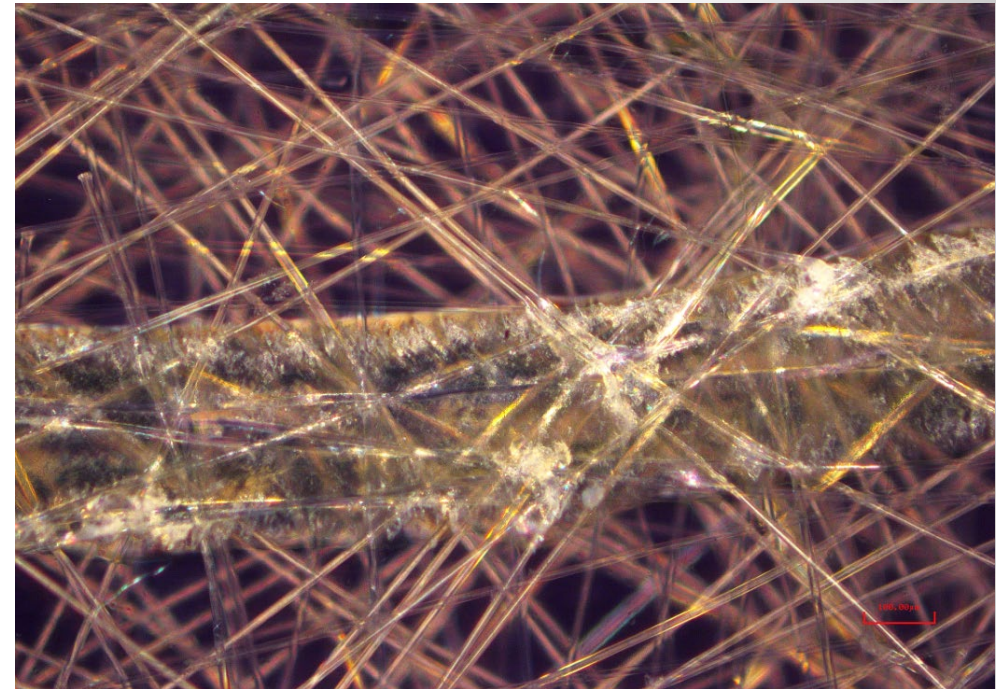


Improving Abrasion and Wear Resistance

An aramid surfacing veil protects the underlying reinforcement from friction wear



Without Surfacing Veil
Underlying carbon weave damaged



With 26 g/m² Aramid Veil
No exposure of or damage to carbon weave

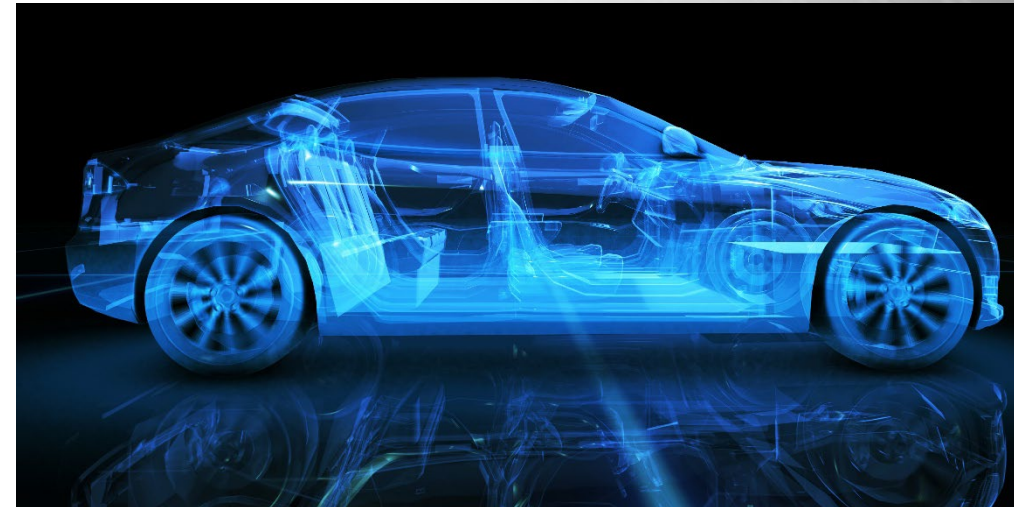
Improving Abrasion and Wear Resistance

KEY BENEFITS:

- Proven to improve abrasion resistance by acting as a sacrificial layer
- Increases the durability and life span of a composite part
- Use of lightweight veils ensures a minimum weight addition

APPLICATIONS:

- High speed composite roll covers
- Sporting goods
- Friction substrate for automotive clutch, brake & transmission system parts

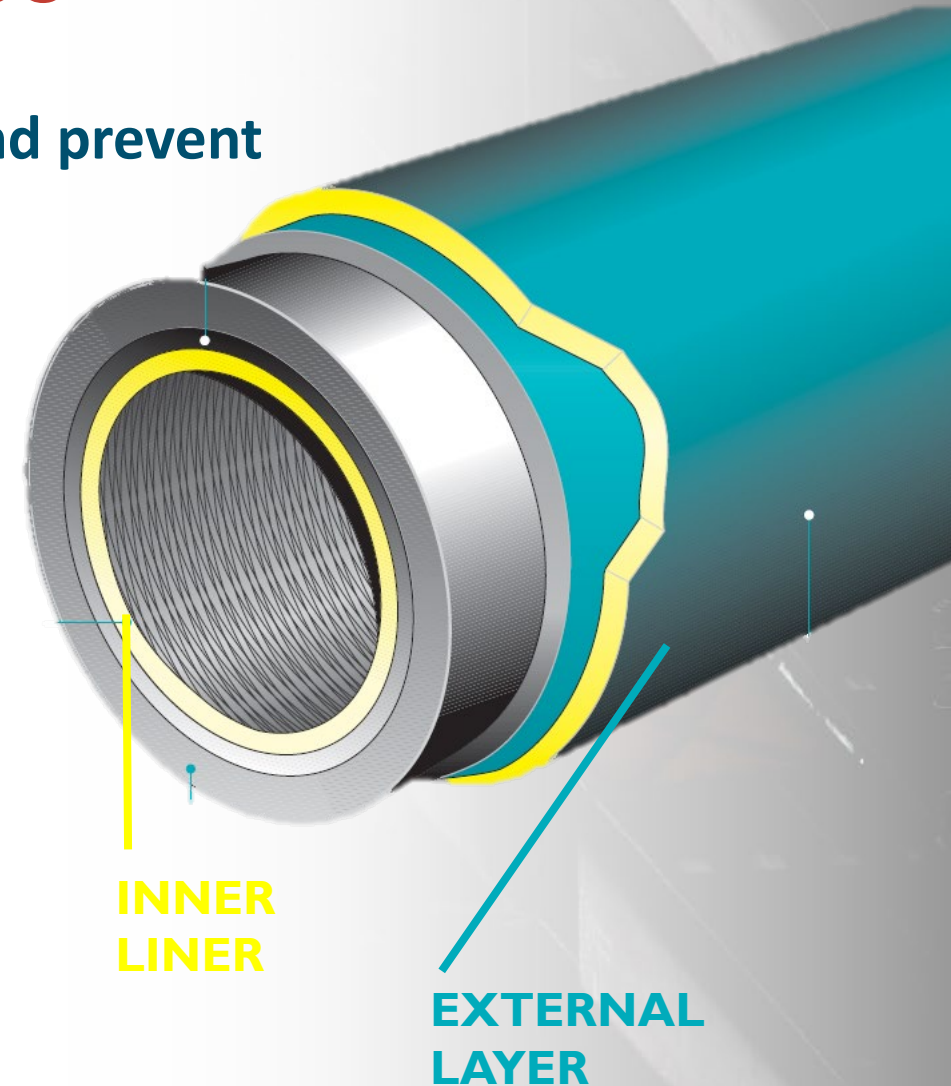


Improving Corrosion Resistance

- Our veils are used to provide chemical resistance and prevent corrosion in highly corrosive environments
 - E.g. Pipework and vessels in chemical industry
 - *Veil used in inner liner for corrosion resistance & on external layer for surface finish*

KEY BENEFITS:

- Easy to incorporate – no additional processing steps required
- Extremely uniform and lightweight to ensure minimum weight addition
- Choice of corrosion resistant veils
 - Glass and polyester



Electrical Conductivity

Providing electrical conductivity to the surface of composite part

- **Conductive nonwovens are made from metal coated fibre manufactured in-house.**
 - Using electroless and electrolytic plating technology
- **The level of conductivity is dependent on the fibre type and areal weight:**

Areal Weight (g/m ²)	Nickel Coated Carbon (20404E) Surface Resistance (Ω/sq)	Copper & Nickel Coated Carbon (20444A/B) Surface Resistance (Ω/sq)
4	3.5	0.6
10	1.5	0.3
34	1.0	0.2
50	1.0	0.1
80	0.8	0.1

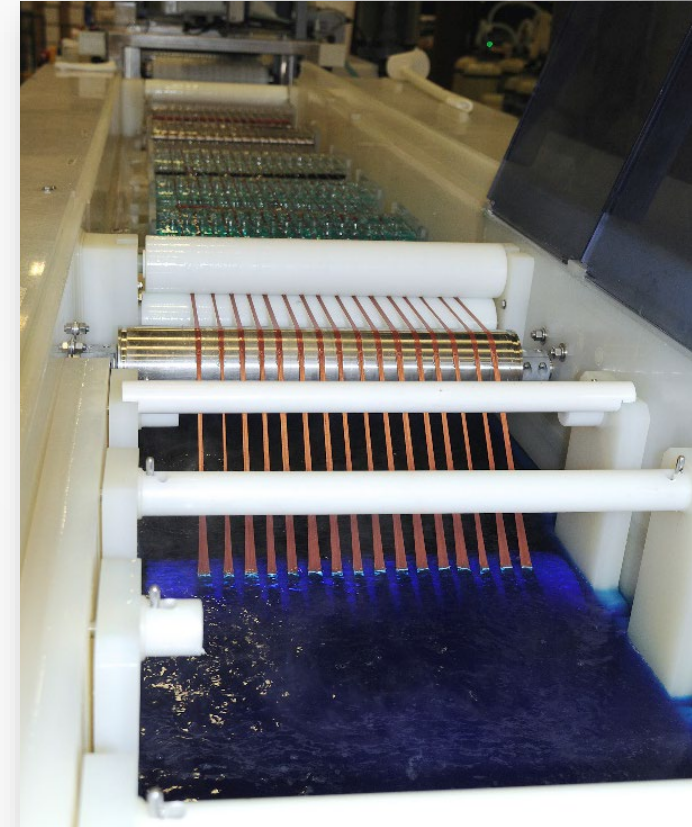
Electrical Conductivity

KEY BENEFITS:

- Easy to incorporate – no additional process steps
- Dual benefit – electrical conductivity with improved surface finish
- Unique level of control over conductivity and shielding properties of fibre – tailored to suit application requirements

APPLICATIONS:

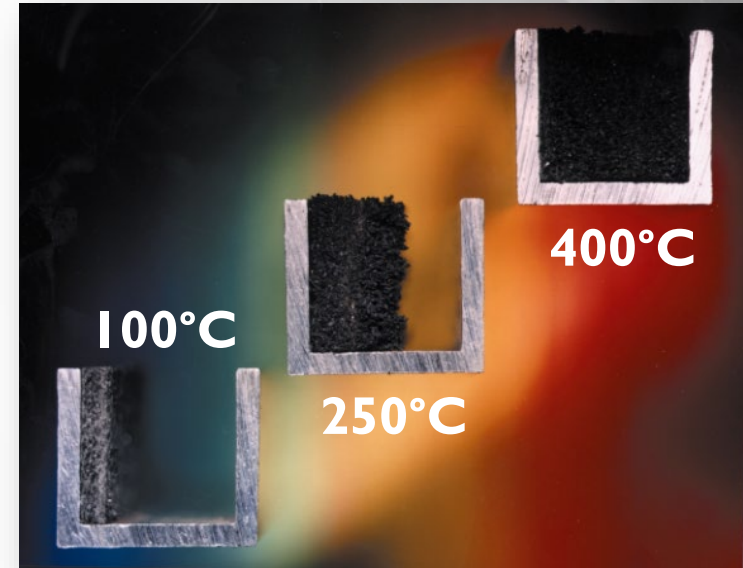
- Static dissipation of electricity



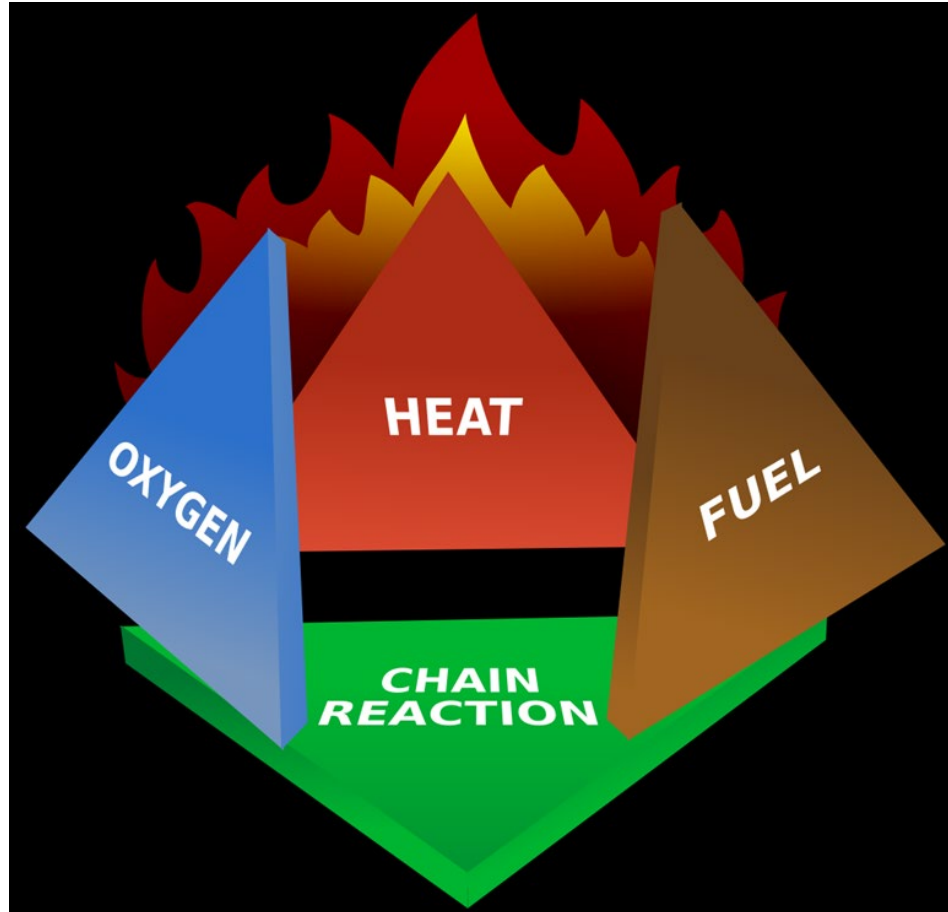
Fire Protection for Composites

Tecnofire® is a range of lightweight intumescent fire protection materials designed for use in composite systems

- **Expansion is activated by heat (190°C)**
- **Tecnofire expands uni-directionally in the Z plane only**
 - Expansion is irreversible
 - 4-35x expansion
- **An exceptionally stable insulating char is produced**
 - This protects the underlying structure from fire & heat
- **Enables composites to pass the relevant industry fire test standards**



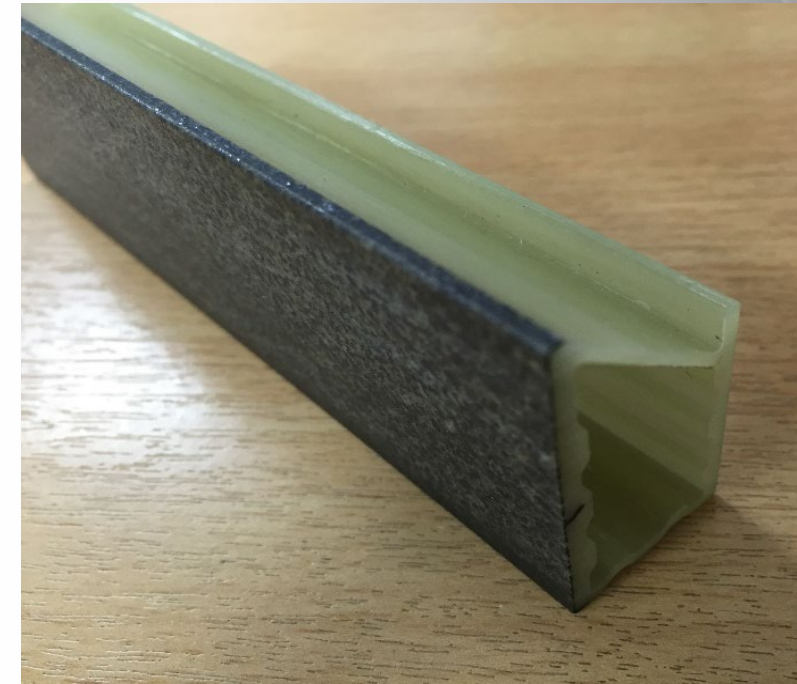
Fire Protection for Composites



- Tecnofire intumescent veils act on all three sides of the fire triangle.

Fire Protection for Pultruded Composites

- Tecnofire can be used in a pultrusion process to manufacture continuous composite profiles with surface fire protection
- Applications include:
 - Roofing panels
 - Decking
 - Bridges
 - Window frames
 - Door frames
 - Architectural products
 - *Steel beam coverings*



Composite Rail Applications – Evaluation to EN45545-2

PART 1: Achieving HL2 R1 using non FST prepreg & Tecnofire E20MI Mat to specified tests

- Panels of carbon fibre reinforced epoxy composites manufactured with & without Tecnofire
 - Control panel made from CFRP prepreg (42% resin), cured at 120°C using compression moulding
 - Tecnofire® panel was produced in the same way, but with E20MI Mat incorporated into each side
- The panels were tested for a range of parameters which are part of the EN45545 standard:

	Control	Tecnofire Laminate	EN45545 Requirement
MARHE (kW/m ²)	177	63	HL2: 60 < x ≤ 90 HL3: ≤ 60
D _s (4)	560	250	HL1: 300 < x ≤ 600 HL2: 150 < x ≤ 300 HL3: ≤ 150
VOF4 (min)	1122	309	HL1: 600 < x ≤ 1200 HL2: 300 < x ≤ 600 HL3: ≤ 300
CIT at 8 min	0.089	0.065	HL2: 0.75 < x ≤ 0.9 HL3: ≤ 0.75



The Tecnofire panel meets the EN45545 requirement for HL2 R1 for the tests undertaken and is close to or passes HL3 for CIT, MARHE and VOF4.

Fire Protection for Composites

KEY BENEFITS:

- **Specially developed Composite grades available**
 - E.g. ATH for smoke and flame spread suppression
- **Suitable for the Pultrusion process, as well as a several standard composite fabrication techniques**
 - Pultrusion, RTM, vacuum infusion, filament winding, compression moulding, centrifugal casting, pre-pregging, hand lay up,
 - Easy to incorporate, requiring no additional process steps
- **Protective layer can be placed at the surface of the profile (close to the fire risk) to maximise performance with minimal added weight**
- **Potentially reduces the need/ level for FST additives in the bulk of the composite (potential to reduce ATH loadings in FST resins)**



Key Advantages for Pultrusion

- High quality surface finish
- Resin rich layer
- Even resin wet out with no dry spots
- High resin compatibility and high wet tensile strength
- Reduced pulling forces and increased pulling speeds
- Reduced die wear
- Even, consistent protection against UV degradation and weathering
- Surface functionality – abrasion & corrosion resistance, static dissipation and improved FST performance

Thank you for listening. Any questions?

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