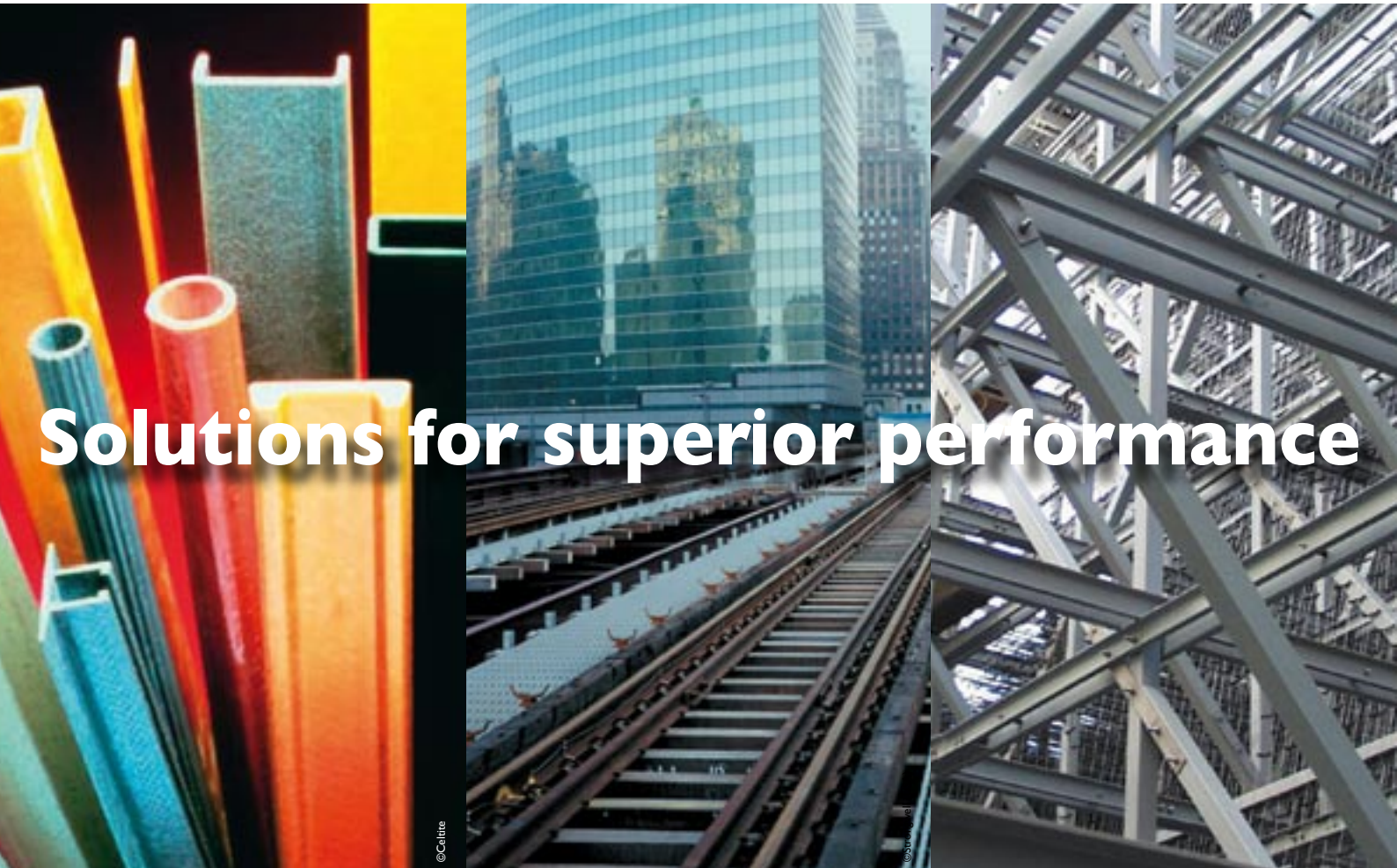


Pultrusion



Solutions for superior performance



OCV[™] Reinforcements



OCV[™] Technical Fabrics

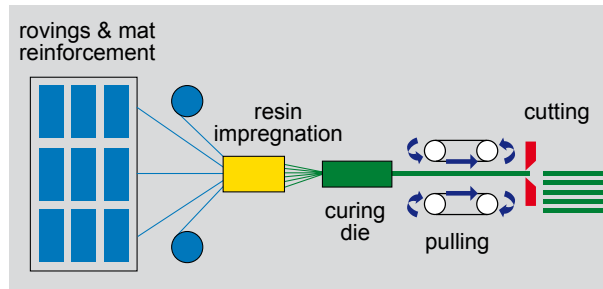


OCV[™] Non-Woven Technologies

PULTRUSION PROCESS

Pultrusion is a continuous process for producing constant-crosssection glass reinforced composite shapes. The process consists of pulling multiple glass fiber reinforcements through a resin bath and into a temperature controlled heated metal die to produce structural profiles of different shapes.

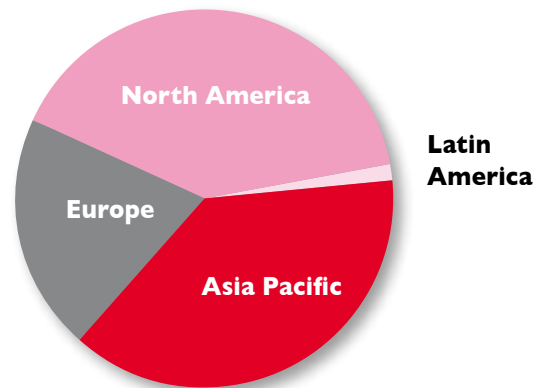
Pultruded components incorporate Single-End rovings for the high lengthwise mechanical properties of the profile, but also bulky rovings to fill in the angles, continuous filament mats and fabrics for crosswise mechanical properties and surfacing veils for a better surface appearance.



PULTRUSION MARKET

PULTRUSION MARKET PER REGION (vol.)

In 1960 there were about 20 manufacturers located primarily in the US, while today at least 90 pultruders are serving the main markets in US, Europe and Asia.

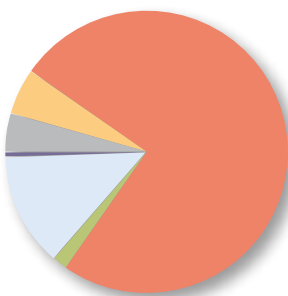


PULTRUSION MARKET BY END USE APPLICATION (vol.)

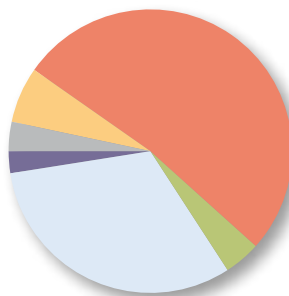
Pultruded profiles are used for many applications in the electrical, corrosion, construction, transportation, military, and consumer goods areas. The global composites market for pultrusion is between 250,000 and 300,000 tons.



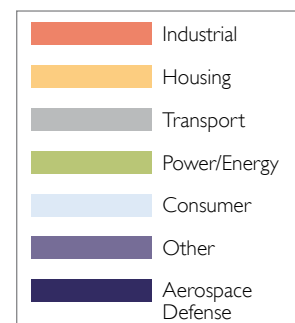
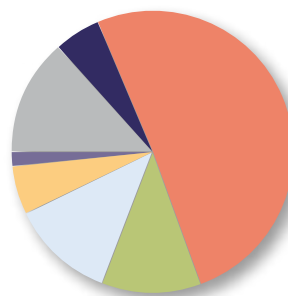
Asia Pacific



Europe



North America



MARKET NEEDS

- Reliable and fast processing
- Cost-effective performance
- . high strength-to-weight ratio
- . corrosion resistance
- . smoother exterior finish
- . enhanced long-term durability
- . optimize resin use
- Product customization
- Efficient design of section geometry

OCV™ SOLUTIONS

- Advantex® Glass
- . Single-End (SE) rovings
- . Unifilo® continuous filament mats
- . Spun, texturized or bulky rovings
- . Appropriate sizings and tex
- . Corrosion Resistance
- Twintex® glass/thermoplastic product
- Alkali-Resistant Glass (AR)
- ECR and C-Glass Speciality Non-Wovens
- Technical Fabrics
- High Performance Reinforcements

ADVANTAGES OF GRP⁽¹⁾ PROFILES VS. WOOD, STEEL OR ALUMINUM

- **In cradle-to-gate analyses of major raw materials, GRP⁽¹⁾ parts are much more environmentally friendly compared to steel and aluminum⁽²⁾:**
- . Less Weight
- . Less Energy to Refine, Transport
- . Less pollutants created (global warming gasses, acidification of air/water, eutrophication, ozone depletion, smog)
- **Additional independent studies⁽³⁾ show finished composite parts to have far superior Life Cycle Analyses profiles compared to the steel and aluminum alternatives.**

(1) Glass Reinforced Plastic

(2) Comparing process; OC Sustainability Study Method TRACI/IMPACT 2002+/IPCC/Energy (Feb 09)

(3) DSM Presentation at 2008 Environment Forum Proceedings ©JEC; ©European Alliance for SMC/BMC 2007, Design for Success, A Design & Technology Manual for SMC/BMC, Chapter 6 Environment; Comparative Environmental Life Cycle, Assessment of Composite Materials, O.M. De Vegt, W.G. Haije, December 1997.

- **Finally, GRP profiles are:**

- . Lighter (up to 70% weight reduction versus steel) and high strength
- . Maintenance free
- . Inherently thermal and electrical insulators (600 to 800 times lower thermal conductivity than metal)
- . Better in flexural strength and tension
- . Easily machined, bolted, riveted and threaded just like steel which makes joining of sections simple
- . Lower in cost due to ease of handling, light weight and lower transportation
- . Long term fatigue performance
- . Chemically and corrosion resistant
- . Heat resistant
- . Dimensional stability
- . Excellent in creep and fatigue performance

OCV™ BUSINESSES PROVIDE A COMPREHENSIVE RANGE OF REINFORCEMENT PRODUCTS FOR PULTRUSION

SINGLE-END ROVINGS



Single-End rovings are generally used in all pultruded products, usually as principal reinforcement

- Provide axial strength and stiffness
- High reinforcement content (typically 55 vol. %)
- Rovings available in a range of tex values (300 to 9600 tex)
- Specifically sized for different resin systems for optimum performance

NA	LA	EMEA	AP	PRODUCT	RESIN COMPATIBILITY				TEX AVAILABLE
					● means primary compatible resin				
					EPOXY	POLYESTER	VINYLESTER	PHENOLIC	
●			●	366	●	●	●		2200, 2400, 4400, 8000, 9600
●		●	●	399	○	●	○		4800, 8000, 8800, 9600
●				424	○	●	○		4400
●				466	○	●	○		4400
●				SE8400LS	●	●	●		4400
●			●	158B	●			●	1100, 2100
●	●			8380				●	4400
		●		R25H	○	●	●		600, 735, 1200, 2400, 4400, 4800
		●		117A	○	○	○		600, 1200, 1800, 2400
	●		●	699				●	2400

NA : North America. LA : Latin America. EMEA : Europe Middle East Africa. AP : Asia Pacific

BULKY ROVINGS



Being filamentised to a greater or lesser extent, producing loops or filaments misaligned from the axial direction

- Provides some reinforcement in the transverse direction to improve shear properties
- Produces a scouring action to clean the die and prevent lost edges in tight radii
- Easy to wet out

OUTPUT	2500 tex	5000 tex	10 000 tex
BOBBIN WEIGHT	8.85 kg (nominal)	8.85 kg (nominal)	9.34 kg (nominal)
CARTON TUBE	76.2 X 78.6 X 265 mm		
BOBBIN EXT. DIAMETER	280 mm (nominal)		
BOBBIN HEIGHT	265 mm (nominal)		

UNIFILO® MATS

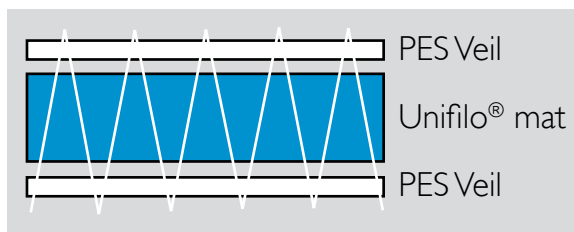


Unifilo® mats are also widely used in pultrusion process for better transverse mechanical properties

- High mat tensile strength, also at elevated temperatures and when wetted with resin
- Low density
- Easy processing: both faces well bound and easy to splice
- Good compatibility with UP, UP(V), EP and acrylic resins
- Available in a full range of weights from 300g/m² up to 900 g/m²
- Full width rolls and slit widths from 9 cm to 50 cm available

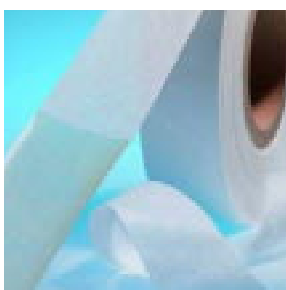
PRODUCT	BINDER	TENSILE STRENGTH	RESIN COMPATIBILITY				APPLICATION
			Epoxy	Polyester	Vinylester	Acrylics	
U527	Lower binder	Lower TS	●	●	●	●	Complex shapes - White parts
U528 std	Standard binder	Standard TS	●	●	●	●	Standard applications
U529	Higher binder	Higher TS	●	●	●	●	High mechanical properties of the finished part
OC M8643 (next U543)	Standard binder	Medium/ High TS		●	●		Standard applications good surface aspect

UNICOMPLEX® PRODUCT



This complex is obtained by sewing a central layer of Unifilo® mat with a polyester surface veil on one or both sides. Unicomplex® C526 is used to improve the surface aspect and to reduce tool wear

NON-WOVENS

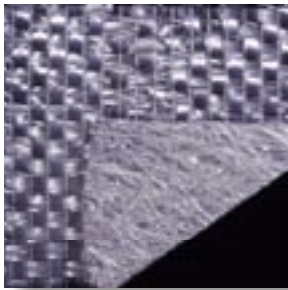


Veils are designed to create a high quality surface layer on the pultruded part

PRODUCT	M524	VL8101
Styrene solubility	Insol	Insol
Fibre type	ECR	ECR
Fibre diameter (micron)	13	23

VL 8101 utilizes 23 micron diameter glassfibres and a small bundle size to give a uniform and veil-like appearance. The fibre structure allows VL8101 to easily wet out in most pultrusion resins. Due to the sizing chemistry, this product is multi-compatible and suitable with most commonly used pultrusion resins.

COMPLEXES, FABRICS, STITCHED AND NEEDLED MATS



Fabrics, complexes and mats - with sufficient tensile strength for processing through a die, and which can be impregnated with resin under operating conditions - may all be used

DESCRIPTION	PRODUCT NAME	STANDARD PRODUCT AREA WEIGHTS - GR/M ²	RECOMMANDATION FOR USE
Veil-Mat	S xxx/PES xxx types	S450/PES35	Designed for Extra-Surface finish requirement and good process ability
Long-fibre stitched glass mat	STMC (C for long fibres)	STMC600	Works in similar way to Unifilo [®] mat, but stitching gives extra pulling strength, and long fibres give better surface finish
Woven Roving/needled mat combinations	R xxx/NM xxx types	R300/NM300	Needling gives loft - Pushes glass into the corners of the die
Stitched unidirectional/mat combinations	U xxx/SC xxx types (C for long fibres)	U420/SC200	High density UD with long fibre mat - gives spring action - very good for high glass content applications

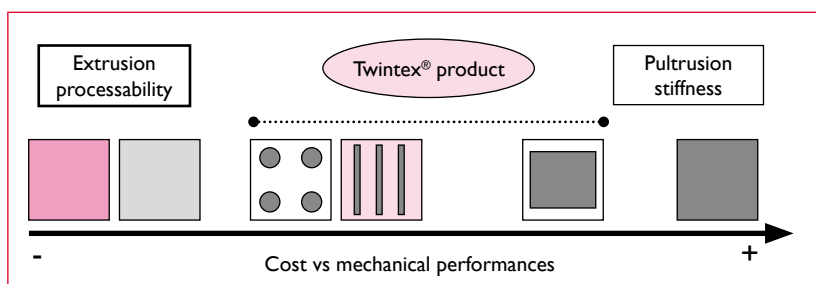
TWINTEX[®] THERMOPLASTIC/GLASS ROVING



Twintex[®] Roving is a unique and ready to use thermoplastic/glass reinforcement, made of commingled E-Glass and thermoplastic filaments, designed for high mechanical properties. Twintex[®] Roving also provides for an efficient and environmental friendly process, high freedom of design, and can be recycled

■ Twintex[®] Roving can be provided with Polypropylene Matrix (PP) and also with co-polyester Matrix (Co-PBT):

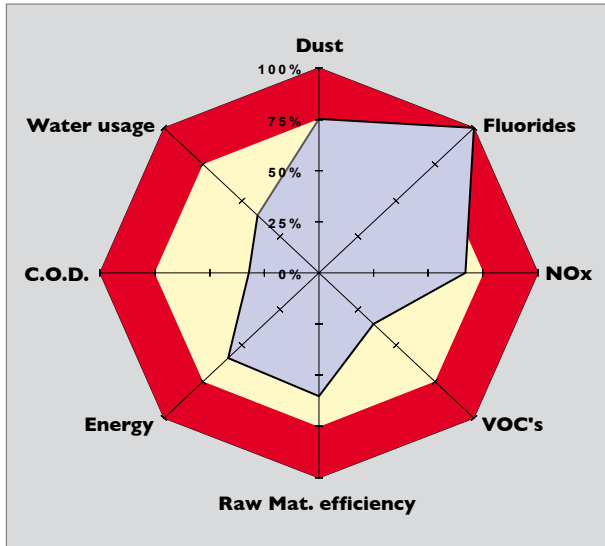
- TR PP 60 1870 (60% glass and 40% PP by weight, 1870 tex)
- TR co-PBT 65 860 (65% glass & 35% co-PBT by weight, 860 tex)



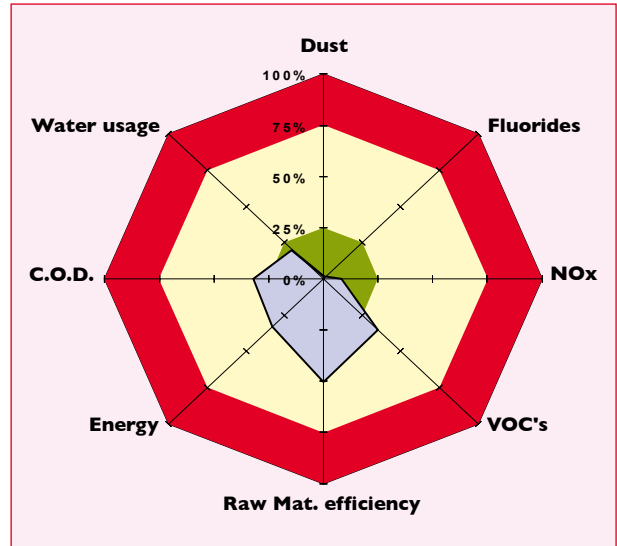
■ Twintex[®] Pul-extrusion concept : Cost effective Technology

ADVANTEX[®] IS THE MOST ENVIRONMENTALLY FRIENDLY E-GLASS

Boron Traditional E-glass



Boron-free Advantex[®] glass



The above comparison was typical for OCV[™] plant conversions. Actual results vary from plant to plant.



OCV[™] BUSINESSES PRODUCE ADVANTEX[®] GLASS

■ With Lower Environmental Footprint:

- a boron-free glass
- a fluorine-free glass

- Both a true E-glass and a true E-CR glass (according to ASTM D578)
- Performing better than traditional E-glass particularly in acids and water and to a certain extent in alkaline solutions
- Allowing material savings versus E-glass
- With a superior resistance to high temperature (higher softening-point temperature)



Structural profiles

Gratings, railing

Bridge

- Up to **54% higher** allowable strain in strain-corrosion resistance, in H₂SO₄
- Up to **50 Years** instead of 3 months lifetime for pultruded rods, in stress-corrosion in salt water (under identical conditions)
- Up to **50 Years** instead of 4 days lifetime for rods, in stress-corrosion in 1N HCl (under identical conditions)

YOUR GLOBAL PARTNER FOR COMPOSITE SOLUTIONS



OCV™ Reinforcements

■ Facilities in 15 countries worldwide



OCV™ Technical Fabrics

■ More than 9,000 employees



OCV™ Non-Woven Technologies

■ More than 15 languages

■ 39% of Owens Corning revenue

■ www.owenscorning.com/composites



OCV™ Reinforcements



OCV™ Technical Fabrics



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