



OCVTM Reinforcements

“Reduced Cost of Ownership and Higher Performance for Aircraft industry with OCV FliteStrand[®] S”



*5th International Conference “Supply on the wings”,
November 2th – 4th, Frankfurt*

*Dr. Eric Dallies,
Owens Corning Reinforcements*



Overview

- **A brief History of Fiber Glass**
- **Latest advances in the production of High Performance Reinforcements**
- **Comparative performance of FliteStrand® S Glass and AGY S-2 Glass®**
- **Select Performance data in Laminates and Sandwich Panels**
- **Lifecycle cost savings**

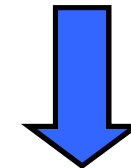
Owens Corning
A history of bringing innovation
to the Composites Market






About Owens Corning



- Founded in 1938, an industry leader in glass fiber insulation, roofing and asphalt and glass fiber reinforcements
- 2009 sales: \$4.8 billion
- 16,000 employees in 26 countries
- FORTUNE 500 company for 56 consecutive years

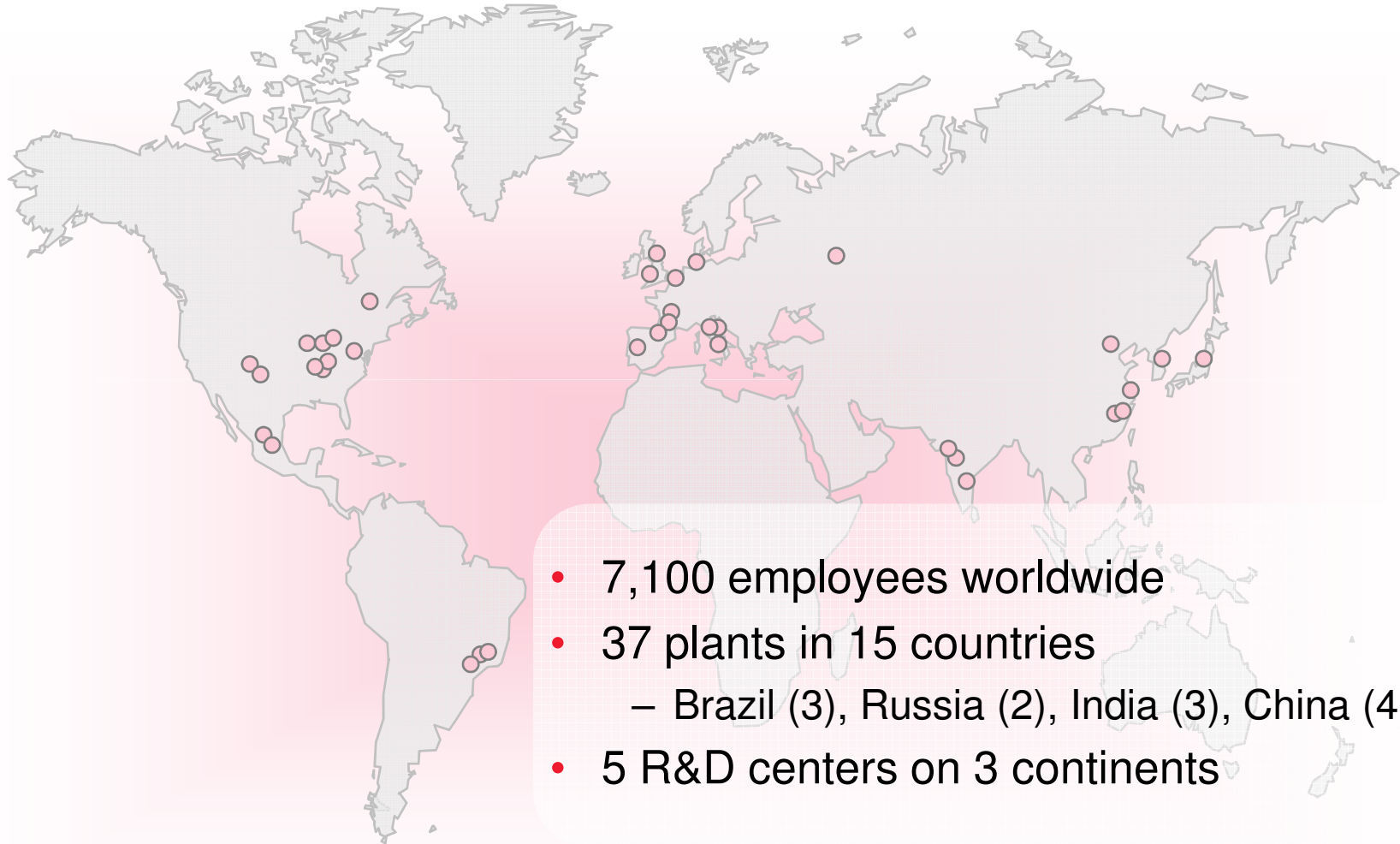


Owens Corning Building Materials and Services	Owens Corning Composite Solutions
<ul style="list-style-type: none"> • Residential Insulation • Commercial & Industrial Insulation • Manufactured Stone Veneer • Residential Shingles • Roofing Asphalts 	<ul style="list-style-type: none"> • Composite Reinforcements <p>  OCV[™] Reinforcements  OCV[™] Technical Fabrics  OCV[™] Non-Woven Technologies </p>



INNOVATIONS FOR LIVING®

Composite Solutions Business



- 7,100 employees worldwide
- 37 plants in 15 countries
 - Brazil (3), Russia (2), India (3), China (4)
- 5 R&D centers on 3 continents

A global glass reinforcement supplier



Composite Solutions Business

Reinforcements



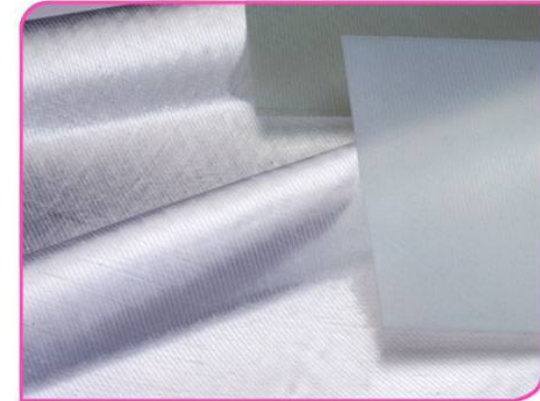
- Advantex® E / E-CR glass
- FliteStrand® S, S-glass
- Niche Hi Perf. glasses

Technical Fabrics



- Wovens
- Knits and Multiaxials
- Specialty Mats

Non Wovens



- Surfacing Veils
- Decorative Finishes
- Pultrusion Mats

Std. E-Glass to Advantex®

High Performance Glass

1950s

1960s

1970s

1980s

1990s

Today



Owens Corning is the world's largest supplier of glass reinforcements



History of Glass & Melting Technology Innovation

- **1938** Owens Corning commercializes E-glass
 - Boron added to glass for electrical properties
- **1968** OC develops S-2 Glass® under US NAVY contract **
 - High Performance Glass (high melting power needed)
 - Small capacity furnaces due to limitations in technology
- **1980** OC develops ECRGlas® (corrosion-resistant)
- **1997** OC develops Advantex® Glass and Technology
 - Breakthrough in melting technology for large capacity furnaces
 - Both and ‘E’ and ‘E-CR’ glass
- **2006** OC develops High Performance Glass (HPG) Technology for R-glass
 - Combines High-Performance Glass and Melting Technology
 - Production of High-Performance Glass in large capacity furnaces
- **2008** OCV develops FliteStrand® S formulation based on proprietary scalable melting technology
 - Boron-free formulation; meets all international standards for S-glass composition and performance



** The S-2 product line and trademark were divested in 1998 and are now wholly owned by AGY, Inc.



S-Glass Fiber Production

Traditional Technology

- Higher Unit Production Cost
- Limited capacity

- Fixed Production Rates
 - New Melters need to be brought on line to increase output or idled to decrease output

- Supply disruption or instability can result

Owens Corning Proprietary Scalable Technology

- Economies of Scale
- Better Batch Homogeneity
- Larger capacity

- Scalable Production Rates
 - Quickly able to scale up or down output to match demand

- Stable Supply Source

Historical concerns with S-glass were high price and unstable supply



Owens Corning S-Glass Enabling Technologies for Markets

Meets the follow S-Glass Specifications

ASTM:	D578 / C162
DIN:	1259
ISO:	278
JIS:	R3410
Mil-R-60346 (Roving)	



Available in both Roving and Fabric form

- Owens Corning HPR Product Brands :
- FliteStrand® Reinforcements - Aerospace
- ShieldStrand® Reinforcements - Defense
- XStrand® Reinforcements - Industrial

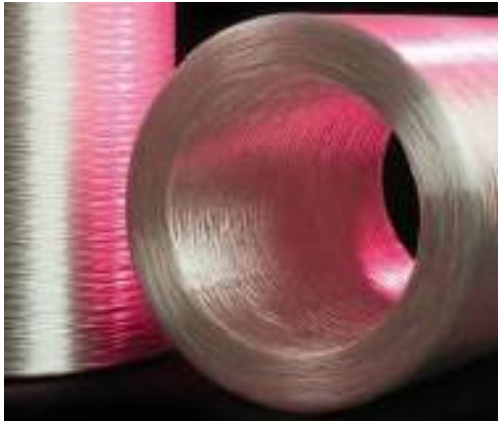
Product forms and processing properties designed to provide seamless drop-in replacement of existing Reinforcements

End Use Applications





FliteStrand[®] S Rovings and Fabrics: Ongoing developments



Rovings

Reduced catenary and twist

Benefits :

- Better resin infusion
- Lower weight UD tape
- Higher utilization and lower costs



Fabrics

High Performance direct-sized fabrics below the cost of S-2 Glass[®] finished fabrics.

Benefits :

- Economically feasible to convert E-glass to S-glass fabric:
 - Significantly higher performance
 - Minimized cost-impact



External Laminate Performance Data (UD Prepreg)

UD laminates constructed and tested by independent third party manufacturer:

9µm, 675tex, MCF14 FliteStrand® S roving, Nominal 185 gsm UD tape, Modified epoxy resin system

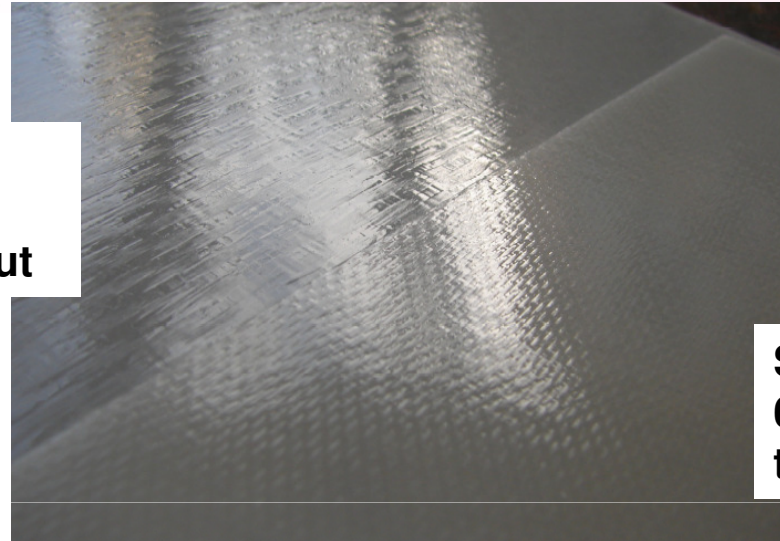
Property	Test Method	Unit	Value
Tensile Strength	ASTM D3039	Ksi	242
Tensile Modulus	ASTM D3039	Msi	7.4
Compression Strength	ASTM D695	Ksi	136
Flex Strength	ASTM D790	Ksi	200
Flex Modulus	ASTM D790	Msi	7.8
Resin Content	ASTM D1652	Wt%	31
Fiber Volume	ASTM D2584	%	53
Areal Weight		g / m ²	187

Data shown for comparative purposes only and should not be construed as a guaranty or warranty of performance. Absolute performance will vary by resin system and process



External Laminate Performance Data (Fabric Prepreg)

FliteStrand® S
Direct Sized WORO
fabric w/ 340 tex input



S-2 Glass®
6781 fabric w/ 68
tex input

• **Fabric Laminate Performance Results**

- 50% improvement in impact resistance with direct sized fabric
- Substantial impact improvement even when hybridized with 6781 fabric
- Direct sized FliteStrand® S panel better flexural strength than E- glass (7781) panel at two-thirds the fabric areal weight.

FliteStrand® S Woven Rovings provides significant weight-savings opportunities



External Sandwich Panel Performance

- **Standard Aircraft Floor Panel** manufactured and tested by independent 3rd party manufacturer
 - 9µm, 675tex, MCF14 FliteStrand® S roving
 - 244 g/m² - 0/90° epoxy laminate facings
 - 8.1 pcf 5052 aluminum core
 - Meets requirements of BMS 4-23 Type II Floor Panel



Long Beam Flexure	Test Method	OEM Requirement	S-2 Glass Roving®	FliteStrand S Roving®
Ultimate Load (lbs)	BMS 4-23	240	305	329
Facing Stress (psi)	AMS-STD -401	-	44,494	47,458
Deflection (in)	BMS 4-23	0.80	0.70	0.59
Panel Shear (lbs)	BMS 4-23	800	957	1,048
Stabilized Core compression (psi)	BMS 4-23	1,400	1,576	1,503

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Photo: courtesy of Teklam –
Corona, California, USA



FliteStrand® S floor panels: A cost effective solution

	Glass Fiber	Carbon Fiber	
Procurement Lower Purchase Cost			Initial Ship Set Price * <ul style="list-style-type: none"> • Glass Fiber Panels: \$45,000 • Carbon Fiber Panel: \$63,800 * Per Aircraft
Operational: Lower Fuel Cost			Fuel Costs* Glass Fiber Panel: \$864,500 Carbon Fiber Panel: \$814,700 *30 year Lifecycle Cost
Maintenance / Repair: Lowest Maintenance Cost:			Maintenance / Repair Cost Glass Fiber Panel: \$157,200 Carbon Fiber Panel: \$345,300 * 30 year Lifecycle Cost

Glass Fiber Floor Panels:
30 Year Net Cost Savings- Over \$157,000 (12.8% per Aircraft)*
 * Cost savings calculation does not include the financial benefit of fewer Aircraft Out-of-Service Incidents

Cost simulation by OCV based on notional Airbus A320 aircraft and comparing standard Glass Fiber / Aluminum sandwich panel to equivalent Carbon Fiber / Nomex sandwich panel.



Summary

- **Through dedicated research, Owens Corning has been able to apply state of the art scalable technology to the production of a true S-glass**
- **Internal and independent external testing indicates that mechanical performance of rovings is statistically and functionally equivalent to S-2 Glass® Rovings**
- **Direct-sized fabrics show the potential to significantly outperform traditional Finished or Greige fabrics and to simplify application design**
- **Owens Corning has brought supply-security and a much more favorable cost/performance ratio to the Aerospace market backed by world-class R&D resources**