Case History

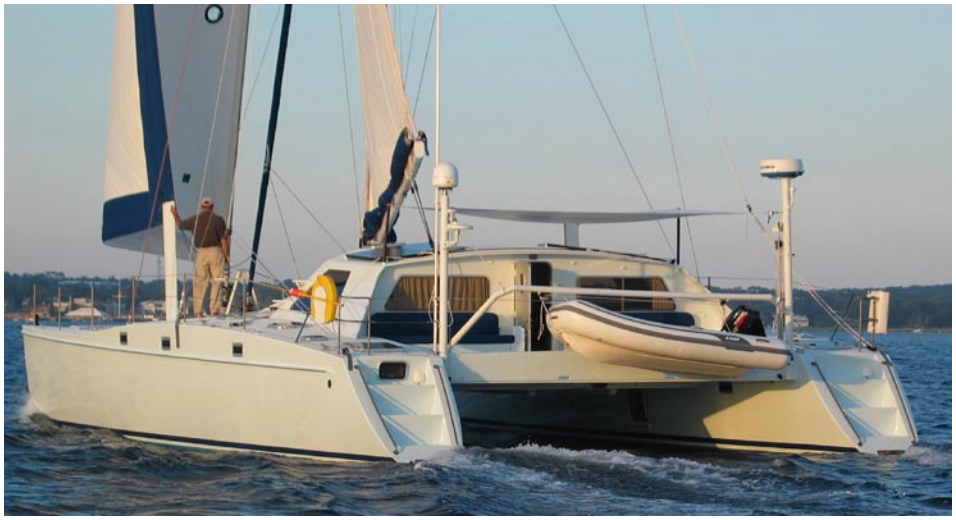
ZenTron® Roving

Affordable High Performance Reinforcement Enables New Marine Applications

Unidirectional Fabric with ZenTron® Roving Allows Boat Builders to Use S Glass

Chris White and Bill Koffler have known about the benefits of S glass for many years but the cost of reinforcing fabric made with the material forced them to keep using E glass. That changed recently when the pair discovered unidirectional fabric made with ZenTron® roving from AGY. White and Koffler found that the price had passed a tipping point that now makes S glass a viable option for marine applications.

Instead of saying, "We can't afford it" once again, White and Koffler said "Let's use it." The beautiful result of that pivotal decision is taking shape in the form of a brand new Atlantic 57™ sailing catamaran.



Atlantic 57™ sailing catamaran

Founder and principal of Chris White Designs, South Dartmouth, Mass., White is a well-known multi-hull designer and the 57′ catamaran's creator. Koffler, founder and owner of Aquidneck Custom Composites, Bristol, R.I., is building the boat. The new "cat" is their second collaboration.

White and Koffler were introduced to ZenTron roving by Rich O'Meara of Core Composites, Newport, R.I. O'Meara said the two are fans of S glass but were not aware of the new fabrics now available with ZenTron roving.

"They remembered the prices of high performance glass fabrics from 10 years ago," said O'Meara, "so they ruled it out. When I told them about fabrics made with ZenTron roving they were very interested.

"ZenTron roving is a single-end product made directly from the bushing with an epoxy-compatible sizing," he continued. "ZenTron roving is less expensive than assembled S glass yarns and the fabrics made from the product are also competitively priced. They decided to use the product after Bill made several test panels and confirmed that the material would provide the performance White demanded."

According to Koffler, their quest for new material began when he wanted to switch to a unidirectional fabric. He and White had collaborated on another 57′ catamaran and were determined to make the second one even better.

"I wanted to use a unidirectional fabric to optimize the laminate, reduce the amount of resin and avoid fairing out humps caused by overlapping fabric," he explains. "Rich recommended a unidirectional fabric with ZenTron roving that would also allow us to add stiffness to the hull and save additional weight. We thought it would cost too much but when we heard the price and considered all of the other benefits, we decided to go with the S glass fabric."

Koffler said he didn't need to see test results to know the test laminates were strong. "I was impressed. You could tell the difference on the shop floor. We were bouncing up and down on them."

He said such strength is important when the big ocean-going catamarans set sail.

"Fully equipped, these are 25,000 pound structures," explained Koffler. "They are 28 feet wide and 57 feet long. They plow through ocean waves at 25 miles per hour. They get pretty loaded with stress but I am absolutely confident that the S glass laminate is up to the challenge."

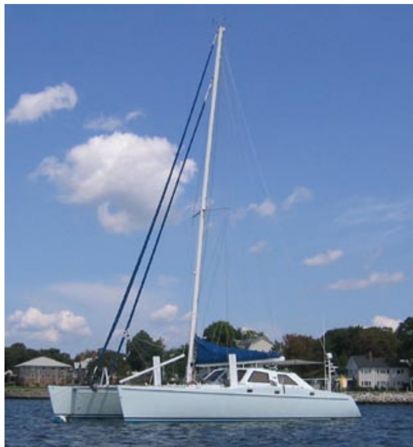
Aquidneck Custom uses a "wet preg" fabrication process that is common in the marine market. The reinforcing fabric is pulled through an epoxy resin bath and squeezed between two large rollers. The material is then combined with **Core**cell™ foam and shaped with vacuum molds to make the hulls and other components.

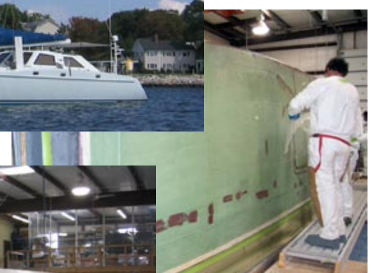
"We want strong laminates but we also want lighter boats," said Koffler. "Our process gets everything completely saturated with no resin-rich voids that add weight but not strength."

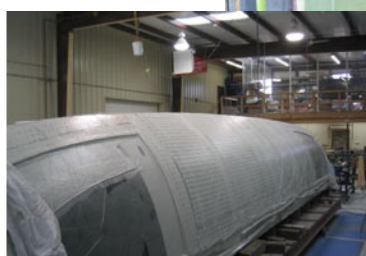
Koffler said the benefits of ZenTron roving go beyond better physical properties and adds a little marketing pizzazz to the finished boat. "It's impressive to tell a potential boat buyer you built it with S glass."

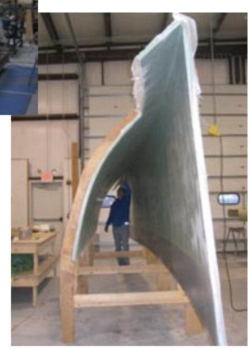
Boat designer White said S glass has always been around but never at what he considered reasonable prices for boat building. He had been attracted to the material's higher modulus and better impact resistance but the increase in cost was always much higher than the improvement in boat performance. Now the two are more aligned, he said.

"Boat building is a very competitive business," he continued. "We need to be careful where we spend our money. Before now, it was hard to justify the improved performance compared to E glass. We use a lot









Construction in process

of glass fiber in our boats so a big difference in reinforcement cost makes a significant difference in the overall cost of the boat.

"By using unidirectional fabric we were able to achieve labor savings that offset a lot of the materials cost increase," added White. "And with higher physical properties, I was able to slightly ratchet back the amount of material used, and that helped both the affordability and the weight.

"With all of the changes we made in materials and fabrication, we took about 5 percent of the weight out of the boat. That 5 percent will translate into a boat that is 2 to 3 percent faster in the water."

White said boat strength is important beyond the loads induced by waves and normal operation. Concentrated point loads and impacts are far more difficult to deal with.

"Launching the vessel, laying on pilings, running into docks and other obstacles are common occurrences for most boats," he said. "You want the boat to be able to take those impacts without costly damage. S glass has very good impact resistance; it can absorb a lot of energy."

The new Chris White Designs catamaran uses some carbon to hold the structure together but White said hulls is not the place for that fiber.

"A carbon hull is a noisy hull," he explained. "Carbon fiber makes a very stiff hull with almost no give to it. They make a lot of racket when they slam into a wave and every little noise is magnified in a carbon hull.

"And noise is a safety issue," continued White. "When boats are quiet the captain won't get as fatigued, and fatigue is the most dangerous situation in ocean sailing. When people get fatigued they make bad decisions and mistakes. S glass reinforcements make a boat more comfortable, more forgiving and safer."

Koffler said safety is an important factor for him as well. "The person we're building this boat for plans to take his family on a round-the-world voyage. We're not building this for a bunch of professional racers; we need to build a sturdy boat a family can enjoy and sail safely. I have a lot of confidence in the performance of this new boat."

"With competitive prices for unidirectional fabrics made with ZenTron roving," White concluded, "I expect to see expanded use of S glass in boat production."

Materials Comparison in Marine Applications

E Glass	*S Glass*	*Carbon*
The standard for boat building for many years	Higher physical properties for stronger and stiffer hulls	Very strong and light fiber
Least expensive	Priced higher than E glass but lower than carbon fiber	Most expensive
Widely available in a wide variety of forms	Good availability in commonly used forms	Often hard to obtain
Easy to fabricate	Easy to fabricate	Can be difficult to fabricate; very itchy when laminates are cut or sanded
Quiet hulls	Quiet hulls	Noisy hulls
Durable	Higher modulus provides more impact resistance than E glass	Tends to be brittle and can be more easily damaged than glass reinforcements

ZenTron® Roving

ZenTron high strength roving is a single-end S Glass roving product that consists of numerous L or T Filament continuous glass strands gathered without mechanical twist into a single bundle and treated with one of two epoxy-compatible size systems.

ZenTron roving is suitable for a number of composite and non-composite processes and applications including weaving, filament winding, pultrusion and texturizing. The 758 size system was developed for composite and reinforcement applications while the 721B size system was developed for texturizing and thermal applications.

ZenTron products are described with the size chemistry designator as well as the nominal yield in yards per pound.

Unidirectional

Unidirectional means the fibers are oriented in the same direction, such as in unidirectional fabric, tape or laminate. Strands of single-end roving are typically aligned and stitched together to form a fabric or mat. These products are often called "uni" or UD.

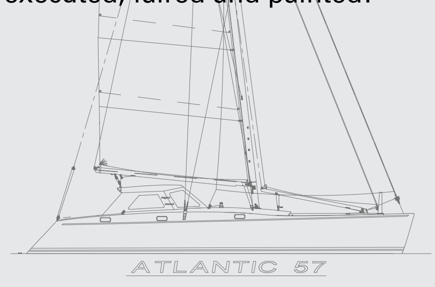
Sources

Unidirectional Fabric with ZenTron® Roving from AGY

- SAERTEX USA, LLC, Huntersville, NC
- SAERTEX GmbH & Co. KG, Saerbeck, Germany
- SciArt, Inc., Drummondville, Quebec, Canada
- Sigmatex UK Limited, Runcorn, Cheshire, UK
- TexIII Weaving, Drummondsville, Quebec
- V2 Composites, Inc., Auburn, Ala.
- Vectorply Corp., Phenix City, Ala.

Excerpt from
www.chriswhitedesigns.com

"Aquidneck Custom Composites did an impressive job of construction. I hesitate to say this because it sounds like marketing hype but I think Lely (their first 57' catamaran) is the best built cruising catamaran ever launched. Detail to detail I'd happily compare her to ANY cat from ANY builder ANYWHERE in the world. ACC's depth of composite boatbuilding skill shows when you look into the bilges and deep into dark corners where the laminates are perfectly executed, faired and painted!"



ZenTron® (0/90)ns Laminate Properties

Property	Test Method	ZenTron		E-glass	Aramid	AS4 Carbon
		Measured	Predicted	Predicted	Predicted	Predicted
Density[1, 2], g/cc	ASTM-D3171	1.53	1.59	1.63	1.26	1.37
Tensile Strength, ksi (MPa)	ASTM-D3039	66.7 (460)	62.0 (427)	44.0 (303)	64.0 (441)	92.0 (634)
Tensile Modulus, Msi (GPa)	ASTM-D3039	2.70 (18.6)	2.76 (19.0)	2.40 (16.6)	3.40 (23.4)	5.90 (40.7)
Compression Strength, ksi (MPa)	ASTM-D695	51.1 (352)	43.0 (296)	33.0 (227)	13.0 (89.6)	69.0 (476)
In-Plane Shear Strength, ksi (MPa)	ASTM-D5379	11.0 (75.8)	10.0 (68.9)	10.0 (68.9)	11.0 (75.8)	10.0 (68.9)
In-Plane Shear Modulus, Msi (GPa)	ASTM-D5379	0.335 (2.31)	0.376 (2.59)	0.373 (2.57)	0.252 (1.74)	0.368 (2.54)
Poisson's Ratio	ASTM-D3039	0.099	0.078	0.089	0.051	0.030
Short Beam Shear Strength, ksi (MPa)	ASTM-D2344	6.4 (44.1)	6.5 (44.8)	7.0 (48.3)	7.0 (48.3)	8.0 (55.2)
Flexural Strength[3], ksi (MPa)	ASTM-D790	72.4 (499)	76.0 (524)	57.0 (393)	33.0 (228)	118.0 (814)

Notes:
[1] Fiber content was 52%wt and 32%v for ZenTron using 6 osy NCF fabric and $[(0/90)_3]_s$ 12 ply layup. Predicted properties from micromechanics and laminate theory for same layup using 32% fiber volume basis.
[2] Matrix: CoPoxy 2117A epoxy/CoPoxy 9263B amine hardner (33 phr), vacuum bag molded at room temperature followed by 8 hr postcure at 150°F.
[3] 16:1 span to depth.

Contacts

Aquidneck Custom Composites
69 Ballou Boulevard
Bristol, R.I. 02809-2729
401.254.6911

Chris White Designs
5 Smith's Way
South Dartmouth, Mass.
508.636.6111
www.chriswhitedesigns.com

Core Composites
Division of ROM
Development Corporation
136 Swinburne Row
Newport, RI 02840
401.846.6008
www.corecomposites.com

Gurit (USA) Inc.
Lauderdale Marine Center
2019 SW 20th Street, Suite 234
Fort Lauderdale, Florida 33315
954.423.9630
www.gurit.com

agy

WORLD HEADQUARTERS/AMERICAS
AGY
2558 Wagener Road
Aiken, S.C. 29801 USA
1.888.434.0945 (Toll free in US)
1.803.643.1501
1.803.643.1180 (Fax)

EUROPEAN OFFICE
AGY – Europe
163 Boulevard des Etats Unis
69008 Lyon, FRANCE
+33.4.72.78.1777
+33.4.72.78.1780

www.agy.com

For more information, visit our Web site at www.agy.com

Pub. No. LIT-2007-231 (03/07) Printed in USA, March 2007