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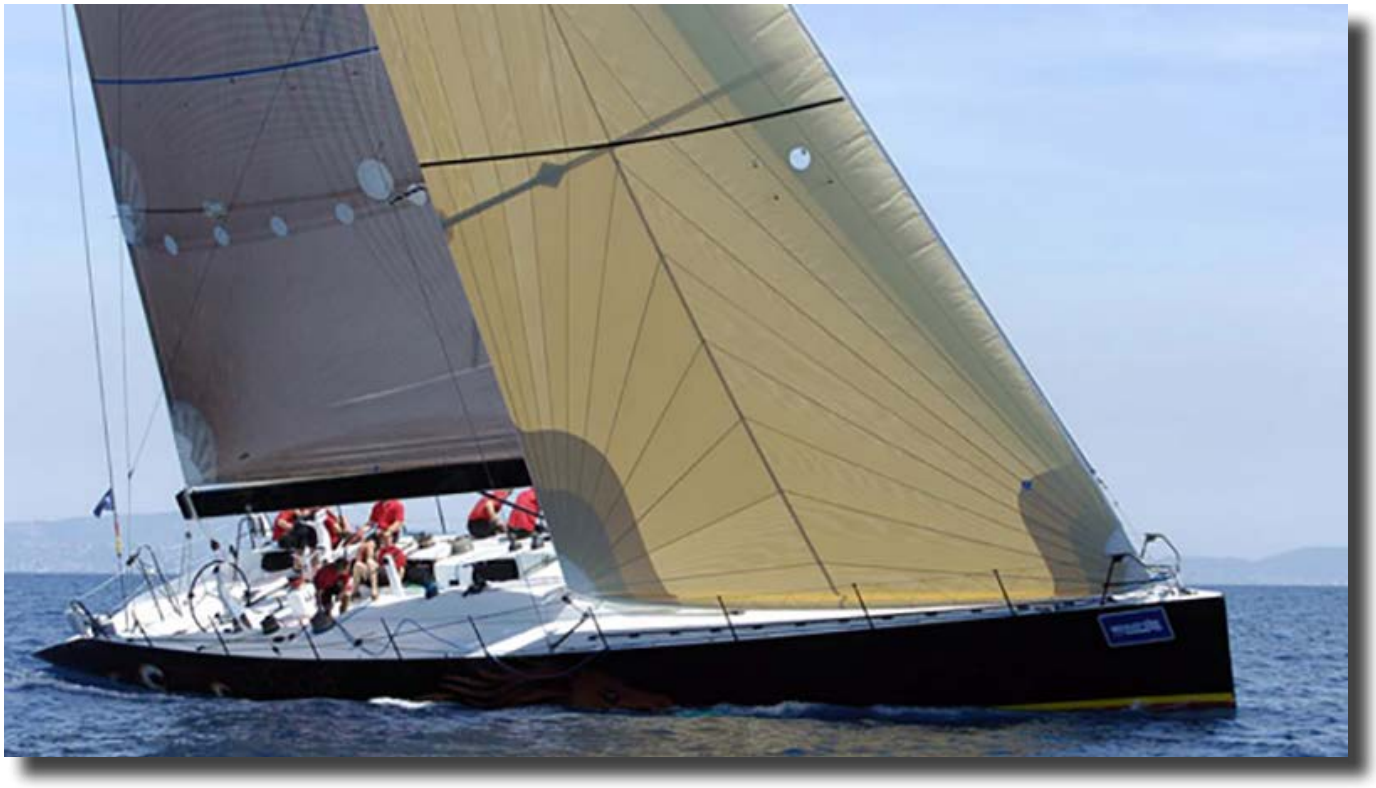
MAXIMUM SAIL POWER

CHAPTER 2

IT STARTS WITH A YARN

A Look at all the Fibers used to Make Sails - Part 5 - Aramids and Liquid Crystal Polymers



ARAMIDS

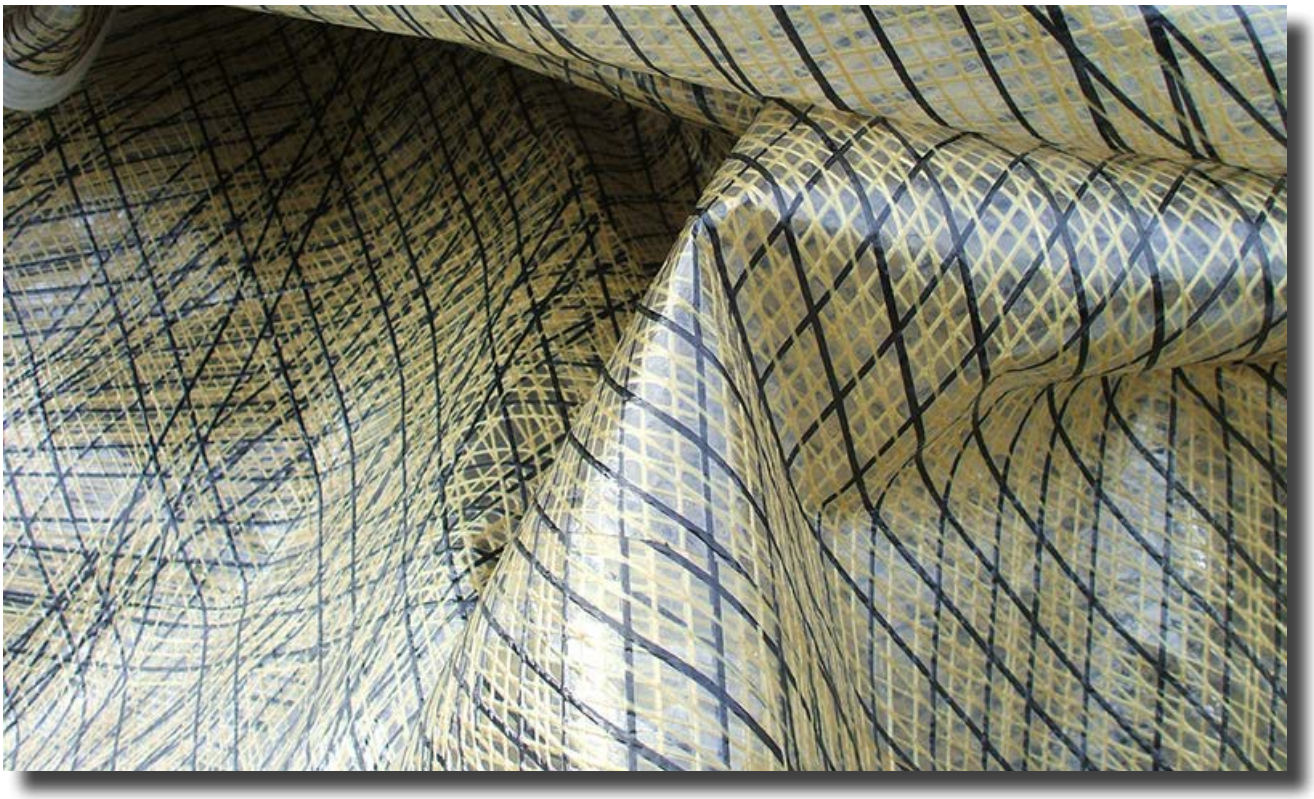
KEVLAR

Kevlar used to be the grand-daddy of racing fabrics. If you wanted to win you had to have Kevlar sails but the fiber is rarely used and has been replaced by Twaron. While Kevlar was very strong with extremely low stretch qualities the individual yarns were very adverse to UV and even small amounts of exposure would degrade

the strength. They were also very sensitive to flex and we all know that sails flex when the flog in the breeze.

TWARON

Twaron is also produced by Teijin and is chemically and physically similar to Kevlar. Like Kevlar, the fiber is a bright gold color. High-modulus Twaron (HMT) has similar stretch properties to Kevlar 49, and it has better tensile strength and better UV resistance. The fiber is in fact gold but is dyed black to help strengthen its UV resistant properties.



Twaron with Technora

TECHNORA

Technora is produced in Japan by a company called Teijin. This distinctive black yarn is similar in modulus to Kevlar 29 with a slightly better flex capacity. The raw fiber is in fact gold, but

fabric makers dye the yarns black to improve the fiber's low UV tolerance. While Technora sails were popular for a while, the fiber is now used mostly as part of a composite laminate with the Technora fibers being used on the diagonal for bias support. Other fibers with improved performance and comparative cost have replaced Technora.

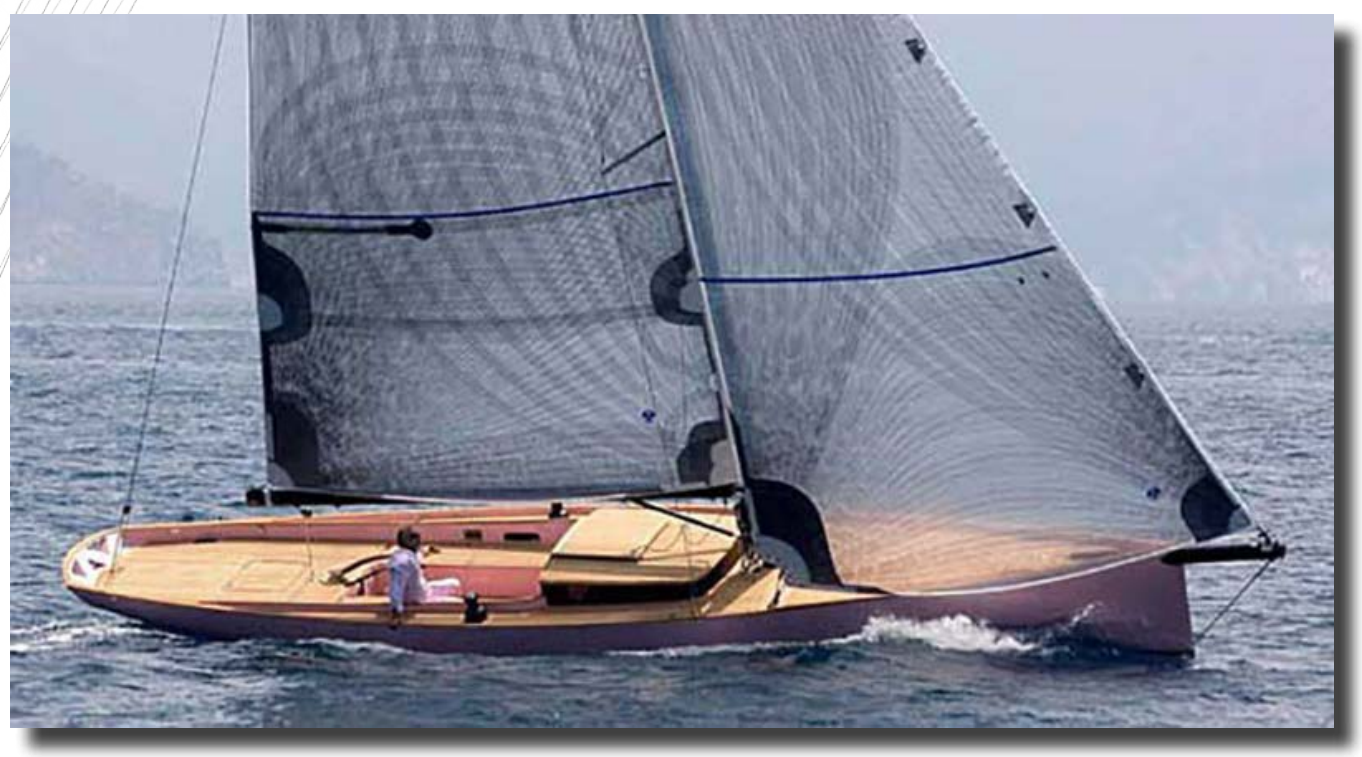
LIQUID CRYSTAL POLYMERS

VECTRAN

Vectran is one of the newer high-tech fibers introduced into sailmaking and because of its strong properties it has gained a foothold in the industry. According to the literature put out by Celanese, the manufacturer of Vectran, it is "a high performance thermoplastic multifilament yarn spun from Vectra, a liquid crystal polymer, and is the only commercially available melt spun LCP fiber in the world." While this sounds impressive, and it surely is, the physical properties of Vectran are even more remarkable. Pound for pound, Vectran is five times stronger than steel and 10 times stronger than aluminium. It has a modulus similar to Kevlar 29 and does not lose any of its strength after being flexed. It has zero creep, high chemical and abrasion resistance, and high tensile strength. Unfortunately, it is also sensitive to light, and unless the Vectran yarns are protected from the sun's UV rays, the fiber becomes weak and breaks. There are two more positive points about Vectran. First, it repels water and therefore does not foster mildew. Second, because the yarns are produced as flat ribbons, they bond extremely well to films and taffetas.

The origin of Vectran. Vectran, like many new innovations, was originally developed for the Defense Industry. They needed a fiber that they could use to make a line to tow listening devices behind submarines. The line had to be extremely low stretch and definitely not elongate over time. The idea was that they would tow the listening device behind the sub at a specific distance and then they would tune out the

noise made by the sub's engines so that they could listen for other vessels. If the line stretched the gig would be up.



CARBON

Carbon fiber is a high-modulus synthetic fiber made from an acrylic containing carbon, hydrogen, and nitrogen atoms, and while it was used successfully for many years to build sailboats, there was a reluctance to make sails out of it because it was both too brittle and too expensive for general use. That's all changed and Carbon is now widely used in both racing and cruising applications.

As part of the process of making the fiber, the carbon is heated in three successive stages until all but the carbon atoms are eliminated. The result is an exceptionally low stretch-for-weight fiber that is usually used as part of a blend when making fabric. When used in sails the carbon fibers are combined with other more durable fibers like Twaron, Spectra, Vectran or Technora. The result is a measure of durability, without a sacrifice in modulus.

Last word about fibers

These days more and more cruising boats are turning to high-tech fibers as there are some very real advantage to having high tech sails even if you are only cruising. If you measure the life of a sail by how long it holds its aerodynamic shape as opposed to how long it holds together, then you are going to get a longer life out of a sail that is highly engineered and built using high performing fibers. The additional upfront costs may indeed save you money in the long run, but that's not the only reason for considering something more exotic for your sails. For all boats there is a need to reduce heeling and pitching as much as possible and they way to do this is to reduce weight aloft. A membrane sail built from a blend of carbon and Vectran will be about 30% lighter than a sail built out of Dacron. A hundred feet up that weight difference translates noticeably into how the boat sails. With the lighter sail there is less heeling and more importantly, there is less pitching. Constant pitching over the duration of a long passage is very fatiguing on the crew, so any way to limit the amount of pitching is good for your crew and an overall performance gain.

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