

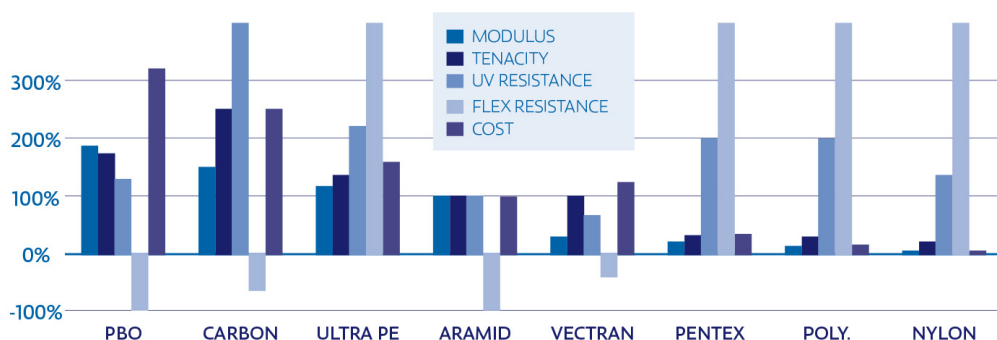
Sailors Guide to Fibers and Fabrics

A sailor's guide to sail fibers

Modern sailcloth begins life as industrial fiber and film. Some of these products are well known to sailors by a specific supplier's brand name; but in many cases the material properties of these products are not especially well understood. A better understanding of the characteristics of these fibers can be helpful in choosing the right sails for your boat.

The ideal sailcloth fiber would last for decades of use, stand up to the harsh sailing environment (toughness and structural durability), would not stretch under load (modulus and shape holding) and would be low in cost. But in the real world, available fibers exhibit varying degrees of these attributes with some materials having vanishingly small levels of stretch for weight, but less than desirable durability, while others are tough, but somewhat stretchy. Finding the right balance of properties for your type of sailing and keeping within budget is the key to being happy with your sails.

Let's start with the various fibers found in abundance in top quality sailcloth, and then look at the more anomalous products that have appeared (and in some cases later disappeared from sailmaking applications).



Polyester has for decades been the most commonly used sail fiber because it is strong, durable and relatively inexpensive. Woven polyester sailcloth is often called “dacron”, in reference to the brand name given by DuPont to their Type 52 Dacron yarn, which was developed specifically for sailcloth and was the industry standard for years. Over the years other suppliers have introduced premium

polyester yarns well suited to sailcloth. Premium polyester yarns deliberately feature very high shrinkage when heated during the finishing process. High shrinkage, combined with very tight weaving, produces sailcloth which is tightly packed and stable without having to rely on on adding excess (and less durable) resins for stability. Polyester fabric is used both as stand-alone woven cloth and as a component in laminates. Polyester yarn is quite resistant to UV damage.

Nylon is widely used for spinnakers and asymmetric spinnakers (Gennakers™) because it is low cost, is lightweight for its strength, and exhibits good UV stability. Nylon is quite stretchy (a big part of why it has very good strength), which is not a liability in downwind sails where some sail stretch is desirable. One warning about nylon to bear in mind: while nylon is a rugged material, it is very susceptible to damage from exposure to chlorine. Never use bleach when washing or rinsing nylon sails, and never soak a nylon sail in a swimming pool.

Aramid fibers are lightweight, have high resistance to stretch and high breaking strength. Not surprisingly aramids are often the fiber of choice for racing sails, and can also be viable in laminated cruising sails, when properly protected from excess UV and flexing. Kevlar® (a Dupont product) and Teijin's Twaron® and Technora® are commonly used aramid fibers in sails. Aramid fibers are often blended with even lower-stretch and higher strength carbon fibers within the same racing sail. While not inexpensive, aramid fibers are moderately priced in comparison to the most exotic fiber types.

Ultra PE (UHMWPE) was originally introduced as a competitor to Kevlar. The brand names Dyneema®, produced by the Dutch company DSM, and Honeywell's Spectra® are familiar to many sailors. These fibers are highly processed polyethylenes which offer very good UV resistance, very low stretch and very high breaking strength. Ultra PE fiber does exhibit some tendency to "creep" (elongate over time when kept under sustained high load). As a result the UltraPE mass in sailcloth needs to be relatively high compared to expected sail load.

"Spectra/Dyneema" has been used primarily on larger cruising boats where reasonable weight, strength and durability are paramount. Ultra PE fiber is expensive, but very long sail life ensures high value in these sails.

Carbon Fiber appeared in sails during the 1992 America's Cup and has since been widely accepted in grand prix sailing – including high end cruising applications.

Carbon fibers are impervious to UV damage and have extremely high modulus (low stretch), but are quite sensitive to flex. If you take a raw carbon fiber tow (yarn) and fold it in your fingers it will snap after only one or two hard folds. Depending on the carbon content and the construction of the sailcloth, crews need to be very careful to avoid flogging and hard creases when flaking or folding a sail. A notable breakthrough in the utilization of Carbon is in blending it with Ultra PE fiber where the two material's complementary properties are synergistic.

Other Fibers – Current and Obsolete

New fibers occasionally come out of the petrochemical company's labs, and often prove to be of limited utility (or just plain unsuitable) for sailcloth applications. North's approach to new fibers is to first carefully examine the laboratory performance figures, determine a likely appropriate use for the fiber, engineer the right fabric design and choose appropriate sail size range. Finally, we require an extensive testing period to make sure any new fiber lives up to its (often unfounded) promises.

PEN, sold under the brand name of Pentex®, is available in a relatively limited range of yarn sizes. PEN fibers are related to polyester (PET) but stretch about half as much (PEN is only 1/5 higher in strength). This relative mismatch between stretch and strength performance means a PEN based sailcloth cannot be truly lightweight in actual use. The cost of PEN falls between polyester and the aramids. PEN use is mostly driven by class and rating rule restrictions where aramid fiber is not allowed. PEN fiber has low shrinkage when heated during finishing, so it cannot be woven tightly like polyester. For this reason, PEN fibers are found only in combination with PET (aka "mylar") film in laminate cloth for paneled sails. PEN does not come in woven form.

LCP (liquid crystal polymer) is a lightweight fiber that performs well for stretch and flex, but is consequentially more sensitive to UV exposure than Aramid. Vectran is the commonly heard brand name for LCP fiber. North Sails does not use LCP in any sail materials as the cost/durability/performance equation is simply not compelling.

PBO is an example of a highly touted ultra-high-performance fiber that failed as a sail material. Made by Toyobo in Japan, it beats all but the most exotic carbon