What were sails made of

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Sailcloth is cloth used to make sails. It can be made of a variety of materials, including natural fibers such as flax, hemp, or cotton in various forms of sail canvas, and synthetic fibers such as nylon, polyester, aramids, and carbon fibers in various woven, spun, and molded textiles.

Viking longships used wool for sailcloth. The cloth was woven in one of three ways, according to locality and tradition: plain weave with individual threads going over and under each other, three-shaft twill with two threads going over and under at each cross thread, and four-shaft twill with thread interwoven with two threads at a time in either direction. Such was the practice from the 11th through the 14th centuries.[1]

Sails could also be made from woven mats of other similar plant leaves and fibers, including those from sugar palms, buri palms, and nipa palms.[16]

The characteristics of a sail are due to design, construction and the attributes of the fibers, which are woven together to make the sail cloth. The following sections discuss the attributes of fibers assuming a good design and careful construction. According to Mahr, there are six key factors in evaluating a fiber for suitability in weaving a sail-cloth:[17]

There is no perfect solution since in most cases the increase of one attribute generally results in the decreased attractiveness of another. Reduced stretch generally also reduces the flexibility causing a trade-off of performance for durability. Solving both problems generally sends the price out of range for most sailors.

Nylon is used in spinnakers because of its light weight, high tensile strength, superior abrasion resistance and flexibility. However, it has a low modulus allowing too much stretch to be suitable for upwind sails. Nylon is more susceptible to UV and chemical degradation than polyesters and its physical properties can change due to moisture absorption.

Technora is an aramid, which is produced in Japan by Teijin, has a slightly lower modulus strength than Kevlar 29 but a slightly higher resistance to flex fatigue. The fiber"s lower UV resistance is enhanced by dyeing the naturally gold fiber black. Technora is most often used as bias support (X-ply) in laminate sailcloth.

Twaron is an aramid, which is produced in The Netherlands by Teijin, is chemically and physically similar to DuPont"s Kevlar. Twaron HM (High modulus) has similar stretch properties to Kevlar 49, greater tensile strength and better UV resistance. Twaron SM is similar to Kevlar 29. Like Kevlar, the fiber is a bright gold color.

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Spectra is an ultra-high-molecular-weight polyethylene (UHMWPE) made by Honeywell, which offers superior UV resistance (on par with PET), very high initial modulus numbers (second only to high modulus Carbon Fiber), superior breaking strength, and high flex strength. However, it also exhibits permanent and continuous elongation under a sustained load (AKA: creep). This results in a change in shape as the sail ages. Because of this Spectra is only used in spinnakers on high performance boats where the sails are replaced regularly.

Equivalent to Spectra, Dyneema is an extremely strong fiber produced by the Dutch company DSM. It is often used by European sailcloth manufacturers, is available in a wider variety of yarn sizes than Spectra, and is growing in popularity. Dyneema DSK78 set a new standard combining the typical high strength to weight ratio, excellent low stretch, abrasion, and UV resistance but added three times better creep performance compared to Dyneema SK75 and nearly two times better than Dyneema SK90.

Hoechst Celanese produces Certran polyethylene similar to Spectra, with about one half the modulus rating of Spectra. It has similar properties to Spectra including superior resistance to flex fatigue and UV degradation but also exhibits creep.

PBO (Poly (p-phenylene-2, 6-benzobisoxazole)) is liquid crystal polymer developed by Japan-based Toyobo under the trade name Zylon. It is a gold fiber with an initial modulus that is significantly higher than other high modulus yarns, including aramids. Among PBO"s desirable properties are high thermal stability, low creep, high chemical resistance, high cut and abrasion resistance, and excellent resistance to stretch after repeated folding. PBO is also quite flexible and has a soft feel. But PBOs have poor resistance to both UV and visible light.