Synthetics: Nylon and Polyester

This section covers *nylon* and *polyester*. The fibers have similar properties with slight performance differences and product applications.

Nylon

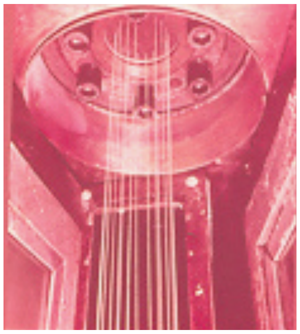
Nylon was the first synthetic fiber and was a breakthrough in textile fiber production. The invention meant less reliance on "nature"—diseases for animals like sheep, and weather and pests for plants like cotton. However, the change meant more reliance on petroleum supplies and with later realization that the plastics in the fibers are harming the environment.

Dr. Wallace Carothers scientist at DuPont invented the fiber in 1931, calling it "fiber 6,6". In 1939 DuPont named the fiber *nylon* and introduced it at the San Francisco World's Fair. The first product made from *nylon* became very popular with women--"Nylons". Until then ladies' stockings were made from cotton or silk. In World War II *nylon* production was directed toward military applications like parachutes. Consumer use returned in 1945 after the war.

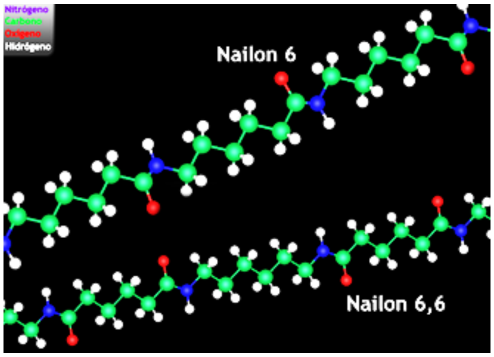
Nylon is made up of carbon, hydrogen, oxygen, and nitrogen formed into long, straight chain molecules called polymers. Raw material plastic "chips" are melted and then forced through a spinneret in a process called "melt spinning." As the hot thermoplastic emerges it is drawn into cold air, solidifying into fibers.

Nylon 6,6 dope before being pushed through a spinneret

https://commons.wikimedia.org/wiki/File:Nylon-6-6.png



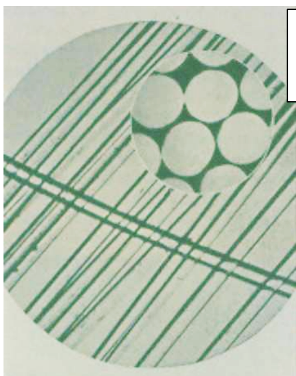
Spinneret (looks like a shower head) with fiber solution being pushed through holes.



nylon 6 and nylon 6,6 long-chain polymers

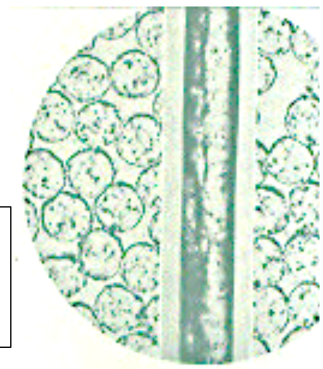
https://commons.wikimedia.org/wiki/File:Nylon6_and_Nylon_66-es.png

Source:Michael Ströck (mstroeck) at en.wikipedia, CC BY 4.0 <https://creativecommons.org/licenses/by/4.0>, via Wikimedia Commons



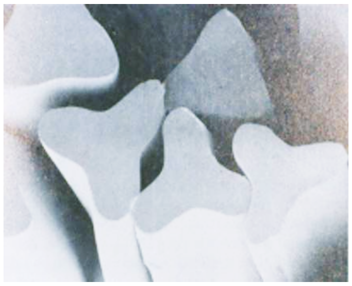
Nylon 6,6 photomicrograph

Nylon with delusterants added to dope before spinning



Under a microscope the nylon 6,6 fibers are round and smooth. The fiber appearance and feel are evident in the fabric, so early nylon fabrics were smooth and reflected light making them shiny. Later manufacturers introduced modifications that were possible due to the process of mixing the dope, forcing through the spinneret and solidifying. The photomicrograph of nylon with delusterants shows a modification to nylon to make it dull—delusterants (typically powdered titanium dioxide) are added to the dope. Delusterants scatter light making the fiber appear dull. Many other modifications are possible.

Shape and size can be changed by changing the shape of the holes in the spinneret and/or changing the speed the fiber is forced through the spinneret. The size of the spinneret opening can be adjusted to change denier of the fiber. If you are a knitter, you may be familiar with denier as a measure of size and weight. The Falke company web site has an interesting guide to nylon tights and hosiery denier (https://www.falke.com/us_en/inspiration/denier-tights-guide/ Retrieved April 15, 2026) .The spinneret opening shape can be changed, for example from round to triangular to imitate the luster of silk.



Triangular cross-section provides soft luster, like silk

Hollow core fiber provides insulation (like a wool fiber with a hollow core

Other modifications made possible with fiber manufacturing processes include:

- thick and thin: pushing dope through spinneret at different speeds
- split fibers (microfibers): fibers split to make a tiny fiber—think of pulling apart "string cheese" into smaller strips.
- Additives to the dope: "solution dye", anti-static, sun-resistant, fire-retardant
- Spinning procedures: add crimp, scatter fibers (fiberfill)

<u>*Nylon* Properties (selected):</u>

High Tenacity: *nylon* is high strength. If you think of fishing line as a very large nylon fiber—try pulling it end-to-end—it's very strong and difficult to break.

High resilience: nylon can be texturized using heat setting methods—setting in "crimp" like wool fibers. Those texturized fibers are very resilient and "springy". Many wall-too-wall carpets are made with texturized nylon fibers—so when carpet is stepped on it springs back to shape.

Low absorbency: nylon does not absorb moisture—a property that can be used to produce fabrics that are water resistant. However, nylon fabrics can be uncomfortable in a humid atmosphere due to low absorbency. Later generation nylon fibers have been engineered to "wick" moisture along the fiber. For example, in a jacket made of wicking fibers, moisture can wick away from the perspiring body to a drier atmosphere outside of the garment.

Prone to static charge build-up: low moisture absorbency also means that static charge can build up. Nylon carpet is prone to annoying static in cold/dry winter weather. Fiber additives have been developed to reduce this problem.

Subject to pilling: Most fabrics made of synthetic staple fibers are subject to pilling—small balls of tangled fibers caused by friction in areas of high wear—underarms, elbows, etc.

<u>Application examples</u>

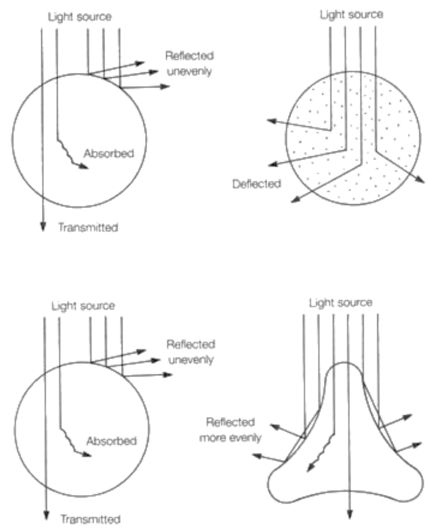
Apparel: especially performance wear (example trade names: *Tactel*, *Supplex*)

Interiors: a major carpet fiber (example trade names: *Anso*, *Antron*, *Zeftron*)

Other: luggage (example trade name *Cordura*)

Polyester

Polyester was developed by DuPont in the U.S. under the tradename *Dacron*. It is like nylon in many ways: petroleum based, raw material chips are melt-spun, and fibers are stretched when the fiber is warm, orienting the molecules and strengthening the fibers. *Polyester* is often used in apparel and many of the *polyester* modifications were developed to improve fabric characteristics. *Polyester* fibers are modified to blend well with other fibers like *cotton*. By blending *polyester* with *cotton* and then spinning it into a yarn (called an *intimate blend*)—*cotton*'s poor performance of shrinking and wrinkling can be reduced. *Wash-and-wear* fabrics introduced in the 1950's were very popular and are used in many products today. A disadvantage of "intimate blend" yarns, blending *cotton* with synthetic fibers, is that the fabric is no longer biodegradable like 100% *cotton* fabrics.



Comparison of light reflectance from a round smooth synthetic fiber (light reflects directly appearing shiny) to a round fiber with delusterants (deflected light—dull appearance) and a tri-lobal fiber (reflected evenly mimicking a triangular fiber—silk)

<u>Properties (selected):</u>

Semi-bright or dull luster: See light-reflectance comparisons in the illustration above.

Strong wet or dry: Washing and drying are no problem if the *polyester* is properly heat-set in production.

Good elastic recovery: To a certain extent can be stretched and will return to shape.

Good resilience: Has some "spring" to it. Customary production streams have meant that *polyester* goes into apparel and household fabrics (like bedding), while not used as often in carpet like *nylon*.

Low moisture absorbency: Closely woven *polyester* fabrics can be uncomfortable in warm climates unless "wicking" properties are incorporated into the fibers.

Resists alkalis: Detergents are typically alkali based—so fabrics of polyester can be washed with detergents.

Will melt: Most apparel fabrics are heat-set to prevent heat damage—follow care label directions to avoid damage.

Application examples

Apparel: *Polyester* blends in many fabrics, performance wear (example trade name: *Coolmax*, *Hollofil*), fiberfill products (example trade name: *Kodel*)

Other: As a film in applications like safety blankets (example: *Milar*)