

U H M W P E

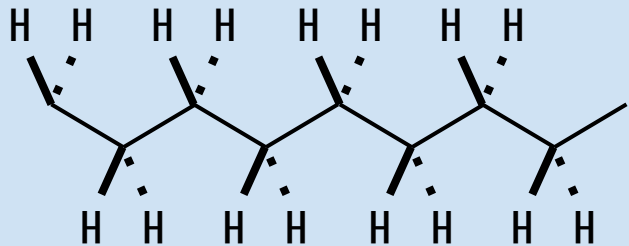
ltra- igh olecular eight oly thylene
Trade Names (Spectra, Dyneema)



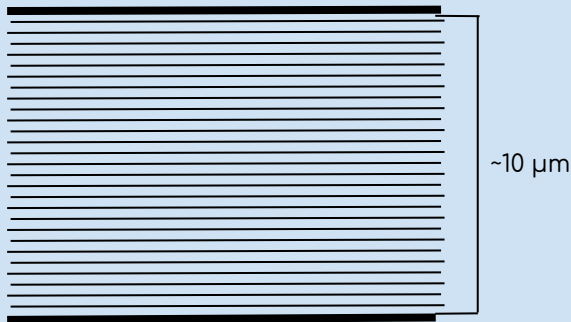
15x stronger than steel (by weight)

What is this?

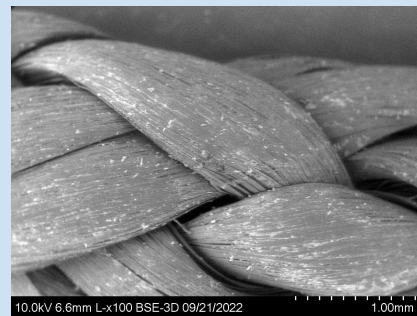
Ultra-High Molecular Weight Polyethylene (UHMW) rope boasts an impressive strength to weight ratio. It is a polyethylene, made from the same chemicals as LDPE (plastic bags) and HDPE (milk jugs). UHMW is different in its extremely long polymer chain length. These chains bond together in a very organized fashion yielding a high amount of crystallization.



A subset of a polymer chain with only 4 ethylene units (UHMW has ~100,000). Each chain is ~0.1-0.2 nm wide and ~10-20 μ m long



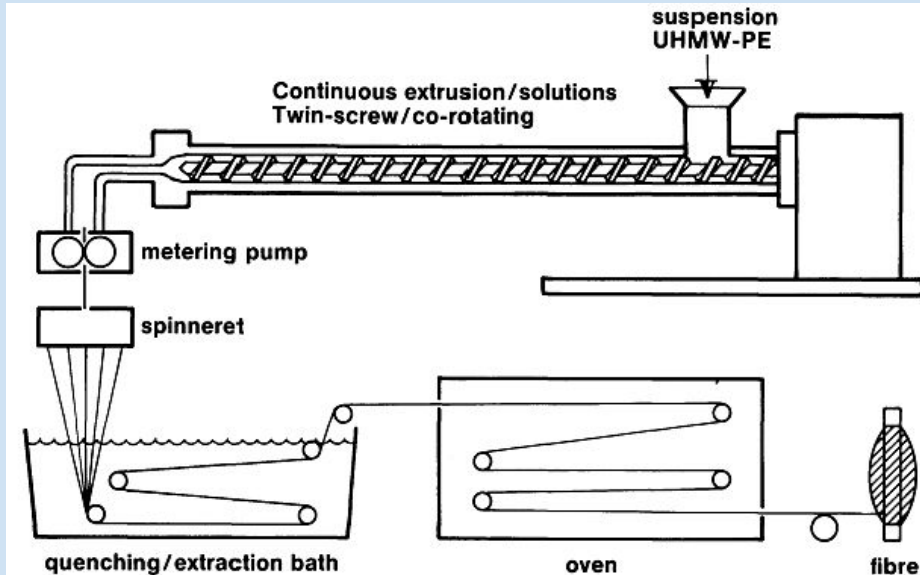
Individual fibers are made up of many chains, likely 50-60 thousand making fibers ~10 μ m wide



SEM image of the rope's braid and individual fibers

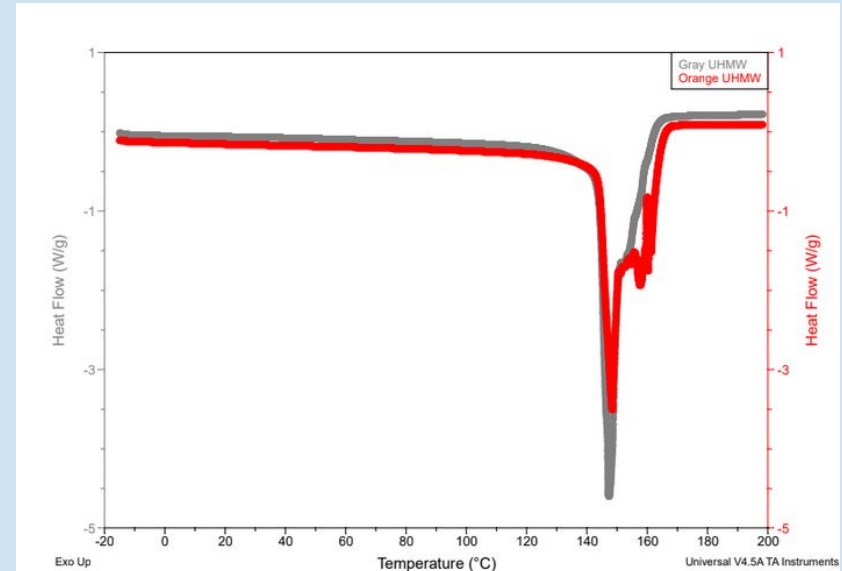
How it's made

Manufacturing UHMW is manufactured by gel-spinning. This process spins fibers out of a polymer gel. The addition of heat and the spinning process allows for high amounts of chain alignment and an extremely crystalline fiber.



What's in our samples?

Using Differential scanning calorimetry (DSC) we examined the composition of our samples. The graph below shows 2 samples' response to heating. The samples show a high degree of crystallinity indicated by the abrupt dip at the relatively high melting temperature.



HOW IT'S USED

UHMWPE is increasingly being used in marine equipment such as winch lines and netting.

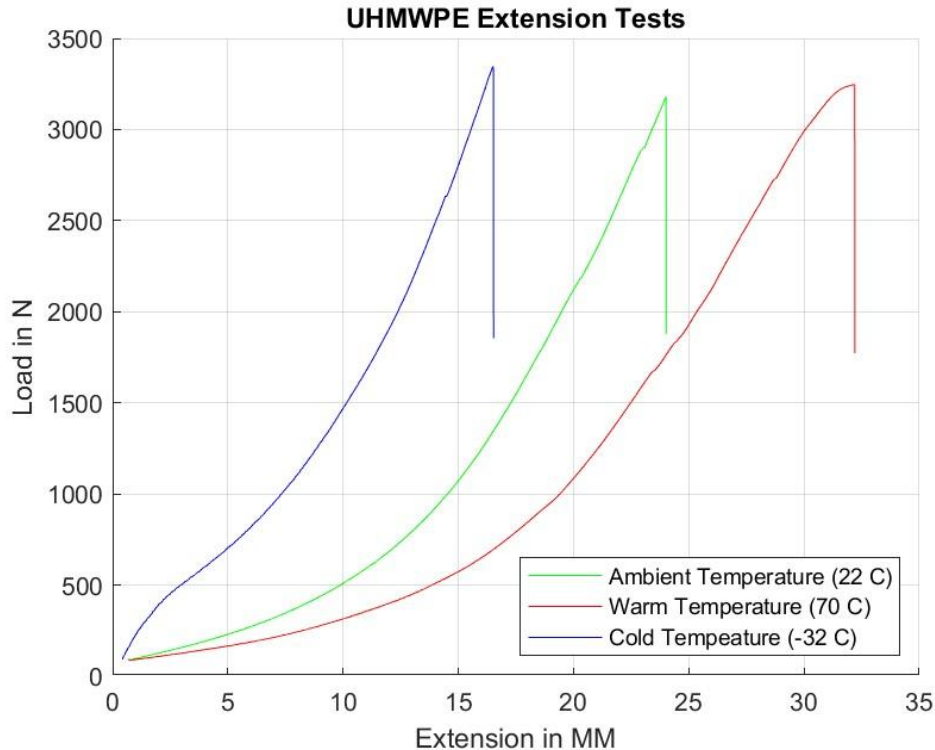


Seiner Boom Winch



Gillnet

MECHANICAL TESTING: TEMPERATURE RELATED ELONGATION

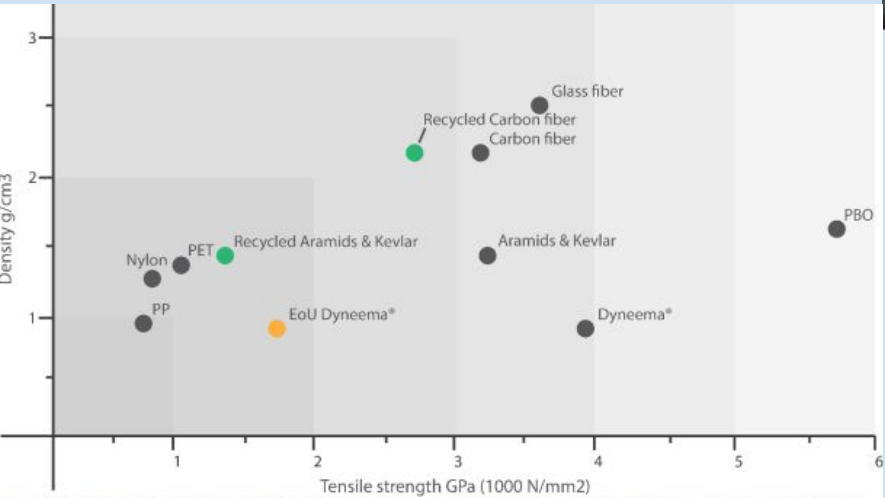


We found in our testing that our UHMWPE line will mechanically fail at roughly 3.2Kn. What seemed to change with temperature is the length the strands would elongate before actually breaking as shown, the strands jumped in elongation (x axis) based on the temperature at which the tests were conducted.

Environmental Costs

Derelict fishing gear can harm wildlife, damage in-use fishing gear and vessels, and pollute our waters and shorelines.

Plastic lines (such as UHMWPE lines) remain in the environment for many years after they are intentionally or unintentionally (by storms or encounters with vessels) cast off.



Graph 2.24: The competitors of Dyneema® fiber and their residual strength after recycling. Source: self-made graph based on table 2.23.

Industry players are currently exploring new purposes for end-of-life UHMWPE lines. These new uses can extend the useful life of these lines, keeping them out of landfills and the environment. Potential uses include geotextiles, textiles, and seaweed farm lines.

Re-use Cases

What Makes UHMWP Special

	Embodied energy, primary production (J/kg)	Price Per KG (USD)	Tensile Strength(Pa)	Melting Point(C)
Spectra 1000 (UHMWP)	4.7 *10 ⁸	85-143	2.5-3.0 *10 ⁹	150-160
HDPE	8.1 *10 ⁷	0.85-0.9	1.9-2.7 *10 ⁷	125 - 135
LDPE	8.2 *10 ⁷	1.14-1.24	8.9-14 *10 ⁶	98 - 115
Polypropylene	6.9 *10 ⁷	1.85-2.64	4.5-6.0 *10 ⁸	160-166
Polyamide PA6 (Nylon)	1.3 *10 ⁸	3.29-3.69	6.0-10 *10 ⁸	200-255
316 Stainless Steel	8.1 *10 ⁷	3.48-4.02	2.4-2.8 *10 ⁸	1370-1400

You Read that Right!
UHMWP costs approximately **100** times as much as other alternative fibers, but it has 10-1000 times the tensile strength.

What is the future of UHMWPE fibers?

As the manufacturing of UHMWPE becomes more affordable, it will likely become more widely used. Due to its incredible properties, it will likely be used in performance outdoor wear. This will mean that garments will last longer but will also take much longer to degrade. As it enters the popular market we will likely see an unnecessary increase in its use, just like other extreme outdoor wear (Canada Goose Jackets).



Sources

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