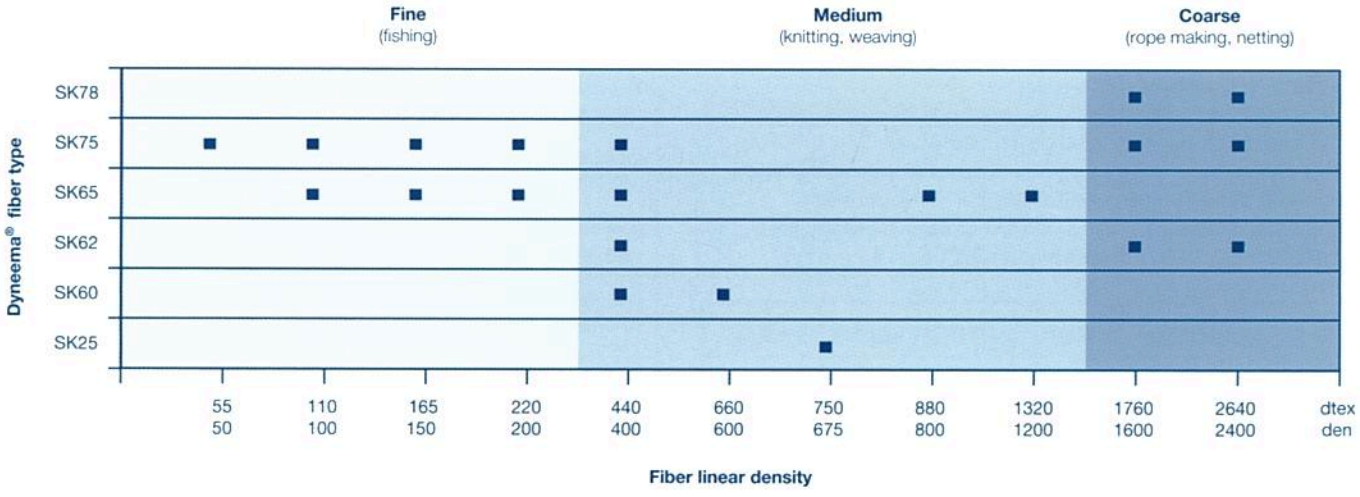
Dyneema® high-strength, high-modulus polyethylene fiber

Dyneema® fiber combines excellent mechanical properties with low density, resulting in high performance-on-weight basis.

The Dyneema® fiber is a gel-spun, multi-filament fiber produced from ultra high molecular weight polyethylene (UHMW-PE), with main characteristics: high strength, low density, low elongation at break, and resistance to most chemicals.
To stimulate developments, this sheet provides an overview of properties measured on Dyneema® fibers. The disclosed data is not valid for any other source of high-modulus polyethylene fibers.

Fiber range.
Dyneema® fibers are produced in three strength ranges and several linear densities with a characteristic very low filament diameter. Especially for medical applications Dyneema Purity® is produced in low linear densities.
The tensile properties are correlated with the fiber linear density. Detailed information per fiber type is available on request, as Product Data Sheets, Product Specification Sheets, Material Safety Data Sheets and Fact Sheets.

Fiber type	Tensile strength			Tensile modulus			Elongation to break %
	N/tex	g/den	GPa	N/tex	g/den	GPa	
Dyneema® SK78 Dyneema® SK75	3.4 – 4.0	38 – 45	3.3 – 3.9	112 – 137	1267 – 1552	109 – 132	3-4
Dyneema® SK65 Dyneema® SK62 Dyneema® SK60	2.5 – 3.4	28 – 38	2.4 – 3.3	67 – 102	759 – 1158	65 – 100	
Dyneema® SK25	2.2	25	2.2	54	608	52	



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Page: 1/4
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Dyneema®
Beyond strength

Mechanical properties.
Dyneema® fibers have a high strength and a high modulus (resistance against deformation) in the fiber direction. In combination with the low density this results in an extremely high strength on weight basis, making it one of the strongest man-made fibers. The elongation at break is relatively low, but owing to the high strength, the energy to break is high. In contrast to other synthetic fibers, the mechanical properties are not influenced by the presence of water.
Due to the anisotropic structure of high modulus polyethylene fibers, the modulus and strength in transverse direction are lower than in fiber direction.
Subjecting HMPE fiber to long-term static loads leads to a permanent elongation called creep. The Dyneema® fiber types have a higher creep resistance than other HMPE fibers enabling their use in various static loading conditions.

MECHANICAL		
Free breaking length	378	km
Axial tensile strength	3.6*	GPa
Axial tensile modulus	116*	GPa
Axial compressive strength	0.1	GPa
Axial compressive modulus	116	GPa
Transverse tensile strength	0.03	GPa
Transverse modulus	3	GPa
Transverse compressive strength	0.1	GPa
Elongation at break	3 – 4 %	
Work to break	45 – 70	MJ/m^3
Creep at 30°C, 300 MPa (Dyneema® SK75)	0.02*	%/day
Creep at 30°C, 300 MPa (Dyneema® SK78)	0.006*	%/day

Thermal properties.
Like other synthetic fibers, the mechanical properties of HMPE fibers are influenced by temperature. The strength and modulus increase at sub-ambient temperatures and decrease at higher temperatures. For long duration exposure Dyneema® fibers can be used from cryogenic conditions up to a temperature of 70°C.

Relative to 23°C	-60°C	+23°C	+60°C	+100°C
Tensile strength	110%	100%	80%	55%
Tensile modulus	110%	100%	85%	60%
Elongation at break	90%	100%	100%	105%

THERMAL		
Melting range	144 – 152	°C
Decomposition temperature	> 300	°C
Advised lowest temperature	No limit	
Advised long duration temperature limit	70	°C
Advised short duration temperature limit (non-constrained fiber)	130	°C
Advised short duration temperature limit (constrained fiber)	145	°C
Coefficient of linear thermal expansion	-12×10^{-6}	1/K
Specific heat capacity	1850	J/kg.K
Thermal conductivity (axial)	20	W/m.K
Thermal conductivity (transverse)	0.2	W/m.K

Chemical resistance.
Dyneema® fiber is very resistant against chemicals. Because it is produced from ultra high molecular weight polyethylene, it does not contain any aromatic rings or any amide, hydroxylic or other chemical groups that are susceptible to attack by aggressive agents.

CHEMICAL RESISTANCE		
Resistance to acids		Excellent*
Resistance to alkali		Excellent*
Resistance to most chemicals		Excellent*
Resistance to water		Excellent*
Aviation Jet A fuel (ISO 1817 test liquid F)	RTCA DO160	Excellent
Hydraulic fluid (ISO 1817 test liquid 103)	RTCA DO160	Excellent
Lubricating oil (ISO 1817 test liquid 101)	RTCA DO160	Excellent
Solvents and cleaning fluid (Isopropyl alcohol)	RTCA DO160	Excellent
De-icing fluid (Ethylene glycol)	RTCA DO160	Excellent
Insecticide (Pyrethroid pesticide)	RTCA DO160	Excellent
Fire extinguishant (Protein, Fluroprotein)	RTCA DO160	Excellent

Physical properties.
Dyneema® fibers feel smooth due to their low friction coefficient. Its low density enables it to float on water. The water absorption in the fiber is negligible.

PHYSICAL		
Natural color	Opaque white	
Density	970 – 980	kg/m^3
Crystallinity	< 85 %	
Filament linear density	1 – 3	dpf
Filament diameter	12 – 21	µm
Filament cross section (other types)	Round	
Filament cross section (Dyneema® SK60, Dyneema® SK65)	Bone shape	
Equilibrium moisture regain	None	
Water pick-up (soaked)	None	
Boiling water shrinkage	< 1%	
Hysteresis loss factor (23°C, 5 Hz)	0.02	
Friction coefficient (yarn-on-yarn)	0.05 – 0.07	

Electrical properties.
Polyethylene is an insulator and has no groups with dipole character. After scouring, the Dyneema® fiber is characterized by a high electrical resistance, low dielectric constant and a very low dielectric loss factor.

ELECTRICAL		
Resistance	>10^{14}	Ohm
Dielectric strength	900	kV/cm
Dielectric constant (22 °C, 10 GHz)	2.25	
Dielectric loss factor	0.0002	

Acoustic properties.
Dyneema® fiber has a high sonic velocity. In the fiber direction, the sonic velocity is higher than in the transverse direction.
The acoustic impedance, the product of density and transverse sonic velocity, is near that of water.

ACOUSTIC		
Sonic velocity (axial)	10000 - 12000	m/s
Sonic velocity (transverse)	2000	m/s

Optical properties.
Dyneema® fibers are visually opaque.
The fiber is invisible to an UV-light source due to the low UV absorption coefficient in combination with no fluorescence or phosphorescence. It is also invisible for thermal imaging devices because of its low IR absorption coefficient and high thermal conductivity. The low reflectivity of radar waves results in a high transparency for radar sources. The refractive index axial to the fiber axis differs from the transverse direction making the fiber perform birefringence.

OPTICAL	
Ultraviolet visibility (UV)	Transparent
Eye visibility (VIS)	Translucent
Near Infrared visibility (NIR)	Highly transparent
Infrared visibility (IR)	Highly transparent
Radar visibility	Highly transparent
Refractive Index (axial)	1.59
Refractive Index (transverse)	1.53
Birefringence	0.06

Flammability.
Fabrics and panels produced from Dyneema® fibers have passed various standards on flammability. Like any other synthetic fiber, it will burn slowly if ignited in atmospheric conditions and is qualified as being self-extinguishing upon removal of the flame.

FLAMMABILITY		
Limited oxygen index	< 20%	
Fabric, horizontal	FMVSS 302	Passed
Fabric, vertical	FAR 25.853b	Passed
Ballistic panel, vertical	DIN 4102	Passed

Dyneema®
Beyond strength

Fatigue resistance.
Dyneema® fiber applications have a higher resistance to repeated axial loading than other fiber types. The fibers combine high strength with high fatigue resistance, even if the loading is partly in compression as in repeated bending of rope applications.
Despite its high modulus, the fibers are flexible and have a long flexural fatigue life. Because of the low friction coefficient and good abrasion resistance, internal abrasion of ropes is usually negligible.

FATIGUE RESISTANCE		
Abrasion resistance (yarn-on-yarn)	ASTM D6611	Excellent*
Abrasion resistance (covered rope)		Excellent*
Cutting resistance (covered rope)		Excellent
Flexural fatigue (fiber)		Excellent
Bending fatigue (rope)		Excellent
Tension fatigue (rope)		Excellent*

Environmental properties.
Dyneema® fiber is used in various outdoor applications under harsh weather conditions. In air the fiber is stable for many years. No special precautions are necessary during processing or storage.
Only strong oxidizing media are able to attack the mechanical properties. Compared to other high tenacity fibers, long term exposure to UV shows the lowest decrease in strength and elongation at break.

ENVIRONMENTAL PROPERTIES		
Visible light exposure		Excellent*
UV-exposure	ISO 4892	Very good*
Weathering	ISO 12224	Excellent
Oxidation (28 days, 80°C, 50 bar)	ISO 13438	Passed

Fungal resistance.
Dyneema® fiber has excellent biological resistance. The fiber neither stimulates undesired growth nor is sensitive to any attack by micro-organisms.

FUNGAL RESISTANCE		
Aspergillus niger	RTCA DO160	Excellent
Aspergillus flavus	RTCA DO160	Excellent
Aspergillus versicolor	RTCA DO160	Excellent
Penicillium funiculosum	RTCA DO160	Excellent
Chaetomium globosum	RTCA DO160	Excellent

Toxicity.
Polyethylene is regarded as biologically inert. The Dyneema® fibers are IARC classified 3 (not classifiable carcinogenic to human) based upon its length weighted geometric mean diameter. This diameter is too large to produce respirable fibers, meaning they will never reach the deeper part of the respiratory tract and fibrogenic or carcinogenic effects on the lung will not occur.

* Detailed information and availability per fiber type, as well as Product Data Sheet, Product Specification Sheet, Material Safety Data Sheet and Fact Sheet, is available via our Premium Distribution Partner EuroFibers BV.

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