Beluns® Plastic

UHMWPE Sheet, Rod & Parts

Property

Product Name: UHMWPE.
Chemical Name and Synonym: Ultra-high-molecular-weight polyethylene.
Grade: UHMWPE 350, UHMWPE 500, UHMWPE 1000.

UHMWPE

Ultra-high-molecular-weight polyethylene (UHMWPE, UHMW) is a subset of the thermoplastic polyethylene. Also known as high-modulus polyethylene, (HMPE), it has extremely long chains, with a molecular mass usually between 3.5 and 10 million amu. The longer chain serves to transfer load more effectively to the polymer backbone by strengthening intermolecular interactions. This results in a very tough material, with the highest impact strength of any thermoplastic presently made.

UHMWPE is odorless, tasteless, and nontoxic. It embodies all the characteristics of high-density polyethylene (HDPE) with the added traits of being resistant to concentrated acids and alkalis, as well as numerous organic solvents. It is highly resistant to corrosive chemicals except oxidizing acids; has extremely low moisture absorption and a very low coefficient of friction; is self-lubricating (see boundary lubrication); and is highly resistant to abrasion, in some forms being 15 times more resistant to abrasion than carbon steel. Its coefficient of friction is significantly lower than that of nylon and acetal and is comparable to that of polytetrafluoroethylene (PTFE, Teflon), but UHMWPE has better abrasion resistance than PTFE

UHMWPE is a type of polyolefin. It is made up of extremely long chains of polyethylene, which all align in the same direction. It derives its strength largely from the length of each individual molecule (chain). Van der Waals forces between the molecules are relatively weak for each atom of overlap between the molecules, but because the molecules are very long, large overlaps can exist, adding up to the ability to carry larger shear forces from molecule to molecule. Each chain is attracted to the others with so many van der Waals forces that the whole of the inter-molecular strength is high. In this way, large tensile loads are not limited as much by the comparative weakness of each localized van der Waals force.

When formed into fibers, the polymer chains can attain a parallel orientation greater than 95% and a level of crystallinity from 39% to 75%. In contrast, Kevlar derives its strength from strong bonding between relatively short molecules.

The weak bonding between olefin molecules allows local thermal excitations to disrupt the crystalline order of a given chain piece-by-piece, giving it much poorer heat resistance than other high-strength fibers. Its melting point is around 130 to 136 °C (266 to 277 °F),[8] and, according to DSM, it is not advisable to use UHMWPE fibres at temperatures exceeding 80 to 100 °C (176 to 212 °F) for long periods of time. It becomes brittle at temperatures below −150 °C (−240 °F).

The simple structure of the molecule also gives rise to surface and chemical properties that are rare in high-performance polymers. For example, the polar groups in most polymers easily bond to water. Because olefins have no such groups, UHMWPE does not absorb water readily, nor wet easily, which makes bonding it to other polymers difficult. For the same reasons, skin does not interact with it strongly, making the UHMWPE fiber surface feel slippery. In a similar manner, aromatic polymers are often susceptible to aromatic solvents due to aromatic stacking interactions, an effect aliphatic polymers like UHMWPE are immune to. Since UHMWPE does not contain chemical groups (such as esters, amides or hydroxylic groups) that are susceptible to attack from aggressive agents, it is very resistant to water, moisture, most chemicals, UV radiation, and micro-organisms.

Under tensile load, UHMWPE will deform continually as long as the stress is present—an effect called creep.

When UHMWPE is annealed, the material is heated to between 135 °C and 138 °C in an oven or a liquid bath of silicone oil or glycerine. The material is then cooled down at a rate of 5 °C/h to 65 °C or less. Finally, the material is wrapped in an insulating blanket for 24 hours to bring to room temperature.