Thermoplastic olefin

Thermoplastic olefin (TPO), thermoplastic polyolefin or **olefinic thermoplastic elastomers** refer to polymer/filler blends usually consisting of some fraction of a thermoplastic, an elastomer or rubber, and usually a filler.[1]

Outdoor applications such as roofing frequently contain TPO because it does not degrade under solar UV radiation, a common problem with nylons.[2] TPO is used extensively in the automotive industry.

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Materials

Thermoplastics

Thermoplastics may include polypropylene (PP), polyethylene (PE), block copolymer polypropylene (BCPP), and others.

Fillers

Common fillers include, though are not restricted to talc, fiberglass, carbon fiber, wollastonite, and MOS (Metal Oxy Sulfate).

Elastomers

Common elastomers include ethylene propylene rubber (EPR), EPDM (EP-diene rubber), ethylene-octene (EO), ethylbenzene (EB), and styrene ethylene butadiene styrene (SEBS). Currently there are a great variety of commercially available rubbers and BCPP's. They are produced using regioselective and stereoselective catalysts known as metallocenes. The metallocene catalyst becomes embedded in the polymer and cannot be recovered.

Creation

Components for TPO are blended together at 210 - 270 °C under high shear. A twin screw extruder or a continuous mixer may be employed to achieve a continuous stream, or a Banbury compounder may be employed for batch production. A higher degree of mixing and dispersion is achieved in the batch process, but the superheat batch must immediately be processed through an extruder to be pelletized into a transportable intermediate. Thus batch production essentially adds an additional cost step.

Structure

The geometry of the metallocene catalyst will determine the sequence of chirality in the chain, as in, atactic, syndiotactic, isotactic, as well as average block length, molecular weight and distribution. These characteristics will in turn govern the microstructure of the blend.

As in metal alloys the properties of a TPO product depend greatly upon controlling the size and distribution of the microstructure. PP and PE form a vaguely crystalline structure known as a spherulite. Unlike metals, a spherulite cannot be described in terms of a lattice or unit cell, but rather as a set of polymer chains that pack down closely next to one another and form a dense core. The PP and PE components of a blend constitute the "crystalline phase", and the rubber gives the "amorphous phase".

If PP and PE are the dominant component of a TPO blend then the rubber fraction will be dispersed into a continuous matrix of "crystalline" polypropylene. If the fraction of rubber is greater than 40% phase inversion may be possible when the blend cools, resulting in an amorphous continuous phase, and a crystalline dispersed phase. This type of material is non-rigid, and is sometimes called TPR for ThermoPlastic Rubber.

To increase the rigidity of a TPO blend, fillers exploit a surface tension phenomena. By selecting a filler with a higher surface area per weight, a higher flexural modulus can be achieved. Specific density of TPO blends range from 0.92 to 1.1.

Application

TPO is easily processed by injection molding, profile extrusion, and thermoforming. However, TPO cannot be blown, or sustain a film thickness less than 1/4 mil (about 6 micrometers).

References

1. J. A. Brydson (1995). *Thermoplastic Elastomers: Properties and Application*. iSmithers Rapra Publishing. pp. 13–16. ISBN 9781859570449.
2. "MRCA | Midwest Roofing Contractors Association" (http://mrca.org/i4a/headlines/headlinedetails.cfm?id=1060). *mrca.org*. Retrieved 2017-07-06.