Polyolefin Elastomers (POE)

PROPERTIES AND APPLICATIONS

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Polyolefin elastomers (or POEs) are a relatively new class of polymers that emerged with recent advances in metallocene polymerization catalysts. Representing one of the fastest growing synthetic polymers, POE's can be substituted for a number of generic polymers including ethylene propylene rubbers (EPR or EPDM), ethylene vinyl acetate (EVA), styrene-block copolymers (SBCs), and poly vinyl chloride (PVC). POEs are compatible with most olefinic materials, are an excellent impact modifier for plastics, and offer unique performance capabilities for compounded products. In less than a decade, POE's have emerged as a leading material for automotive exterior and interior applications (primarily in thermoplastic olefins [TPOs] via impact modification of polypropylene), wire and cable, extruded and molded goods, film applications, medical goods, adhesives, footwear, and foams.

Most commercially available POEs are copolymers of either ethylene-butene or ethylene-octene. Today, a wide array of products is available with properties ranging from amorphous to crystalline, and low to very high molecular weight.

POEs are often chosen over alternatives because they are:

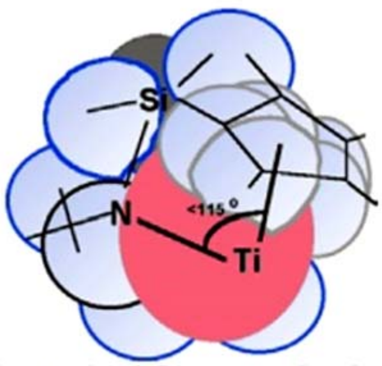
- Suited for thermoplastic or thermoset (peroxide or moisture-cure) applications, either as the main polymer or as a value-enhancing ingredient in compound formulations
- In pellet-form for use in both batch and continuous compounding operations
- Providing superior elasticity, toughness and low temperature ductility
- Designed to optimize processing and end-use performance
- Saturated polymers providing excellent thermal stability and UV resistance
- Recyclable

POEs are being adopted in a variety of applications and markets resulting in global demand approaching 200 metric tons since their inception in the early 1990s. This volume should double by the mid-2000s with increasing demand and projected production expansion.

CHEMISTRY AND MANUFACTURING PROCESS

Polyolefin elastomers are copolymers of ethylene and another alpha-olefin such as butene or octene. The metallocene catalyst selectively polymerizes the ethylene and comonomer sequences and increasing the comonomer content will produce polymers with higher elasticity as the comonomer incorporation disrupts the polyethylene crystallinity. Furthermore, the molecular weight of the copolymer will help determine its processing characteristics and end-use performance properties with higher molecular weights providing enhanced polymer toughness.

POEs are produced using refined metallocene catalyst often referred to as single-site or constrained geometry catalysts. These catalysts have a constrained transition metal (generally a Group 4B metal such as Ti, Zr, or Hf) sandwiched between one or more cyclopentadienyl ring structures to form a sterically hindered polymerization site. This unique catalyst provides a single polymerization site instead of the multiple sites of conventional catalysts and provides the capability to tailor the molecular architecture of ethylene copolymers. (Note: Metallocene catalysts and process technologies can also be used to produce ethylene propylene rubbers). The metallocene catalyst can be used in a number of polymerization processes including slurry, solution, and gas phase operations. The catalyst is usually first mixed with an activator or co-catalyst, which can significantly enhance the polymerization efficiencies to beyond a million units of polymer per unit of catalyst. Very low levels of the catalyst mixture are continuously metered into a reactor along with a predetermined ratio of ethylene and comonomer of choice. The molecular weight of the polymer continues to build with the polymerization of ethylene and comonomer at the catalyst site until stopped by catalyst deactivation or chain termination with hydrogen introduction to the reactor.



Constrained Geometry Catalyst
(Ref. Dow Chemical Company)

Polymerization is very exothermic and requires efficient heat removal from the transport media of gas or solvent. Furthermore, reactor conditions must be carefully maintained to avoid loss of process control. Post-reactor processes involve additives addition and isolation of the polymer from the transporting media and the high catalyst efficiencies generally do not require removal of the deactivated catalysts. The final product is then packaged per manufacturer capability and end-user need, but can range from bags to railcars. See Figure 1

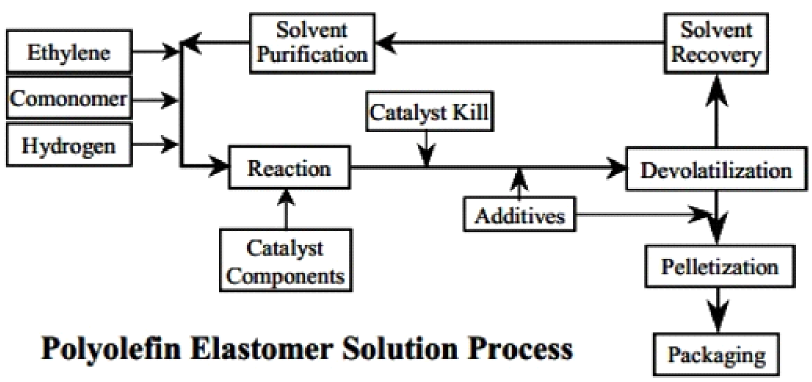


Figure 1

CONCLUSION

Polyolefin elastomers have proven their viability in flexible plastics applications and use in a variety of industries. Further advances in application development, product design, and manufacturing capabilities will provide increasing opportunities for years to come.

GENERAL REFERENCE

"Metallocene-Based Polyolefins: Preparation, Properties, and Technology", Volume 2..... Edited by John Scheirs and Walter Kaminsky, John Wiley & Sons, Ltd., published 1999 ISBN 0-471-98086-2.