

## ***Thermoplastic Polyolefin (TPO) and Vulcanizate (TPV) Elastomers (01/02S1).***

Thermoplastic polyolefinic elastomers (TPOs) were initially produced as blends of a soft (amorphous) component, such as an ethylene-propylene rubber (e.g., ethylene-propylene-diene copolymers or ethylene-propylene copolymers), with a hard component, such as a crystalline polyolefin (e.g. polypropylene or high density polyethylene). The attractive forces (physical) between the resin and rubber phases act as weak “cross-links”. Some products are produced with chemical-curing agents to obtain a chemical cross-link to the rubber.

The relative proportions of the copolymer rubber and polyolefin plastic can vary, but elastomeric blends of TPOs and TPVs usually contain 60-80 weight percent copolymer rubber, with polypropylene accounting for the remainder.

More recently, advances in polypropylene manufacturing processes have permitted the direct polymerization of propylene/ethylene copolymers “*in-situ*” or in the reactor. This capability in theory permits the manufacture of a complete continuum of ethylene/propylene polymers, and blurs the distinction between TPOs and impact polypropylene in predominantly propylene containing materials, and TPOs and ethylene “plastomers” which are predominantly ethylene containing materials. Consequently, some definitions are in order.

For the purposes of this report, a TPO is defined as an *in-situ* polymer containing between 26 and 55 weight percent ethylene; essentially all of the remainder is propylene. Small amounts of additional comonomers may also be present so as to provide unique properties or functionality (e.g. unsaturation so as to permit vulcanization). Propylene polymers with less than 26 percent ethylene are fairly hard, have relatively poor elastomeric properties, and are classified as impact polypropylenes. Polymers containing greater than 55 percent ethylene are quite soft, and also have relatively poor elastomeric properties. Consequently, these materials are considered to be ethylene plastomers. Furthermore, any polypropylene/ethylene-propylene rubber blend is considered to be a TPO.

Fully or partially cured thermoplastic polyolefinic systems are called thermoplastic vulcanizates or TPVs. Such materials have superior strength, high-temperature mechanical properties, hot oil and solvent resistance, and better compression set than partially cured material. These materials are almost always “dynamically cured”, which refers to the process whereby the rubber phase is vulcanized during melt-mixing with the molten non-crosslinked plastic. Static curing occurs when the rubber is cured prior to mixing with polypropylene.

Thermoplastic elastomers have processing advantages over vulcanized rubbers. They are completely reprocessable with little product loss. They can be fabricated into shaped articles by molding and extrusion in conventional thermoplastic machinery without vulcanization. In contrast, the vulcanized rubber scrap cannot be recycled.

In 1972, Uniroyal Chemical introduced “TPR” as the first olefinic based TPE, following the widespread success that DuPont enjoyed with its introduction of COPE TPE (“HYTREL”) in 1971. This marked the initial offering of a polypropylene and EPDM blend. Several major chemical companies followed suit, among them Exxon, DuPont, Ciba-Geigy, and BF Goodrich, by introducing various polypropylene compounds modified with different rubbers to yield wide ranges of hardness. But the lack of substantial market growth in the 1970s caused most major producers to sell these businesses to small compounders.

TPO elastomers began to gain recognition, most notably in the automobile industry, in the 1980s as very basic olefin and elastomer compounds with a high elastomer content of 60 percent or greater. Due to increasing emphasis on performance, especially from the automotive industry, the average elastomer content has dropped to as low as 50 percent or less, and olefin content and additives have been increased to improve TPO properties and performance.

TPVs were first introduced commercially in 1981 by Monsanto. SANTOPRENE materials are polypropylene-EPDM dynamically cured products. Subsequently, Monsanto developed and introduced other dynamically cured polypropylene/rubber products. For instance, GEOLAST polypropylene/nitrile rubber was introduced as a replacement for nitrile rubber thermosets. The Monsanto patent estate, which passed to Advanced Elastomer Systems (AES) when Monsanto and Exxon formed a joint venture from their respective TPV businesses, was quite strong, and served to restrict entrants into this market until recently when key patents expired.

This new report from Nexant Chem Systems presents the chemistry, process technology, production economics and market outlook for both TPO and TPV elastomers.

=====

Nexant, Inc./Chem Systems ([www.chemsystems.com](http://www.chemsystems.com)) is a leading management consultancy to the global energy, chemical, and related industries. For over 30 years, Chem Systems has helped clients increase business value through assistance in all aspects of business strategy, including business intelligence, project feasibility and implementation, operational improvement, portfolio planning, and growth through M&A activities. Chem Systems has its main offices in White Plains (New York) and London (UK), and satellite offices worldwide.

These reports are for the exclusive use of the purchasing company or its subsidiaries, from Nexant Chem Systems, 44 South Broadway, 5<sup>th</sup> Floor, White Plains, New York 10601-4425 U.S.A. For further information about these reports contact Dr. Jeffrey S. Plotkin, Director, PERP Program, phone: 1-914-609-0315; fax: 1-914-609-0399; e-mail: [jplotkin@nexant.com](mailto:jplotkin@nexant.com); or Heidi Junker Coleman, phone: 1-914-609-0381, e-mail address: [hcoleman@nexant.com](mailto:hcoleman@nexant.com), Website: <http://www.chemsystems.com>