THERMOPLASTIC POLYURETHANES OFFER THE VERSATILITY NEEDED FOR TODAY'S AND TOMORROW'S PRODUCTS

The following article, written by Alliance Polymers' Roger Huarng, was published in a recent issue of Modern Plastics Encyclopedia

Polyurethanes are polymers containing the urethane linkage. They have been of great commercial importance for more than 50 years, with many applications including foam (furniture and automotive seating, insulation, carpet underlay), coatings (automotive and architectural paint), and adhesives and sealants, as well as for a variety of other special applications.

The extremely versatile and popular category of thermoplastic polyurethanes, known as TPUs, fills the void between flexible thermoset rubber and rigid thermoplastics. They serve as replacements for many other materials with their abilities to be formulated into a number of variations in chemistry and structure to meet the precise needs of a particular application.

Developed in the early part of the 20th century, and finally fully commercialized in the 1950s, polyester-based and polyether-based polyurethanes (often referred to as PUs, PURs or TPUs), were the first major elastomers that were able to be processed by standard processing methods.

Features Make the Difference

There's good reason for the popularity of polyurethanes since they provide a myriad of appealing benefits and features. Depending upon the grade selected, they are:

- easy to process with standard techniques including injection molding, extrusion, blow molding, calendaring, slush molding and thermoforming
- available in a variety of hardnesses, ranging from 50 Shore A to 85 Shore D
- outstanding with their low temperature flexibility and fatigue resistance
- tough and durable
- unparalleled with their abrasion resistance
- tear and cut resistant
- oil, grease, fuel, solvent and chemical resistant, especially polyester TPUs
- fungus and microbial resistant, especially polyether TPUs
- resistant to creep in load bearing applications
- available in halogen and non-halogen FR (fire retardant) grades
- available in polyester and polyether chemistries
- provide ultrasound transparency
- suited for both soft and rigid applications
- light weight (especially as a metals replacement)
- provided with good elasticity qualities
- hydrolytically stable and naturally antimicrobial for polyether TPUs
- Provided with good color stability with UV additives
- offer excellent adhesion strength to many different substrates in overmolded soft-touch applications
- recyclable
- formulated, when required, with good-to-excellent transparency, especially with polyether TPUs

When You Should Consider TPUs

Polyurethanes move quickly to the top of a designer's or manufacturer's list of preferred materials when the goals are, among other things, toughness/tensile strength, good aesthetics, appealing hand feel (haptic), abrasion resistance and low-temp flexibility as well as other beneficial physical properties such as good impact resistance and tear strength, plus a wide selection of hardnesses.

In recent years, new thermoplastic polyurethane offerings have come along that push the performance envelope – these are non-plasticized soft TPUs, low density TPU foams for products like shoe soles and cable, high heat TPUs for wire and cable applications, TPUs with a low coefficient of friction and new formulations to compete with flexible PVC, PP (polypropylene) and polyester in elastic nonwovens.

Newer, non-plasticized, soft TPUs with special polyester chemistry, crystallize quickly (for short molding cycles and for facilitating thin-wall extrusion), yet have the same molding characteristics as plasticized TPUs with the same hardness (60 to 75 Shore A). The difference is there is no gradual increase in hardness with time, particularly useful in overmolding applications. Current products applications include bearing dust covers and seals and mounting-plate rings, where requirements call for pressure deformation resistance, ball joint seals and numerous other applications.

The inherent tacky nature of soft TPUs has seen the development of special grades that don't require typical additives in order to reduce or eliminate tackiness. They feature a lower coefficient of friction while maintaining transparency. These new offerings have a coefficient of friction about 90% lower than previous grades, offer a wider procession window in blow molding and sheet extrusion processing. Since tackiness is eliminated without lubricants, waxes or inorganic fillers, the potential for blooming or adverse affects on performance, transparency, surface roughness or adhesion on the end product is eliminated.

Recent developments in light TPU foams, with density as much as 60% less than previous TPUs, open new doors for improving existing applications in cable jacketing, tubing, profiles and sheet.

New grades of both polyester- and polyether-based formulations that boost performance have come onto the scene, offering high elasticity as well as high strength along with good sealing capabilities. The primary advantages of these new TPUs over non-elastic polypropylene or PET materials are their ability to make bi-directionally elastic non-wovens in a single step and end-products that provide better sealing, recovery and filtering performance.

Still not convinced by the maverick performance of polyurethanes? According to industry data, the popularity of polyurethanes (more than 15.4 US tons or 14 million metric tons sold and used annually, with a high growth rate over the past 25 years), continues to grow at ambitious rates (8% or more), with the top four application segments being building and construction, transportation, furniture and bedding and appliances, closely followed by packaging, textiles, fibers and apparel and machinery and foundry.

The evidence is most convincing for a bright future for the PU industry, with polyurethanes taking the lead in applications calling for dependable performance, ruggedness and design freedom.

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