Thermoplastic Elastomers: The Softest Materials Solving Your Hardest Problems

Beyond the materials, finding a good partner in a TPE supplier makes a difference with technical support, regulatory know-how and geographic reach.

TEKNOR APEX can be contacted at the Corporate Headquarters - Americas, telephone: 401.725.8000, toll free (USA only): 800.556.3864. For Europe, the Middle East and Africa, telephone: 31.46.70.20.950. For Asia Pacific, telephone: 011.65.6265.2544. More information at www.teknorapex.com or send us an email at info@teknorapex.com.

Thermoplastic elastomers (TPEs) are the premier choice of soft, elastomeric materials for appliance designers and engineers. The market for TPEs continues to grow, due to their cost effectiveness and their versatility or design flexibility, enabling TPEs to be used in many major end-user markets; including consumer products, electronics, medical devices, automotive, HVAC, and other industrial applications.

Just as the name indicates, thermoplastic elastomers combine the performance benefits of rubber with the processability of plastics, yet are more versatile than either material. TPEs can be formulated to exhibit a wide range of properties and characteristics, unachievable by a rubber or plastic alone. Therefore, TPEs are continuously used to displace thermoset rubber, like EPDM or silicone, and soft plastics like flexible PVC, in various applications and markets.

Although rubber exhibits excellent heat and chemical resistance, processing rubber parts is imprecise and often requires auxiliary operations like trimming or gluing. TPEs are considered a more sustainable alternative to thermoset rubber, both environmentally and economically, as TPEs are recyclable and can be used in very complex designs using more efficient manufacturing processes. TPEs can be injection molded into parts with intricate geometries, extruded or co-extruded into complicated profiles at fast line speeds. In addition, TPEs can be co-molded or 2-shot molded onto a rigid substrate like PC or ABS, enabling TPEs to provide cushioning, a soft-touch grip or even a water-tight seal in various applications.

Advantages of TPEs over Thermoset Rubber	
• Lower overall processing costs	• Recyclable
• Reduced scrap	• Less Energy Intensive
• Allows designers more options	• Superior colorability

Advantages of TPE over PVC	
• Phthalate-free	• Improved colorability
• Halogen-free	• Superior elastic properties
• Lower density/lighter parts	• Greater service temperature range
• Better weather resistance	• Remains flexible at sub-zero temperatures

Typical Properties	Conventional TPE	TPE-V
Density (g/cm3)	0.9-1.3	0.9-1.0
Hardness Range (Shore A)	5A to 70D	25A to 55D
Lower Temperature Limit	-70C	-60C
Compression Set	Good	Excellent
Chemical Resistance	Poor	Good
Colorability	Excellent	Fair/Good
Tensile Strength	Good/Excellent	Fair/Good
Elongation at Break	Good/Excellent	Fair/Good
Adhesion to Engineering Resins	Good/Excellent	Poor
Design Flexibility	Excellent	Fair/Good

Flexible PVC also has many advantages, like good UV stability and scratch resistance, and overall, it presents a nice balance of price and performance. However, there is movement away from PVC in the medical industry for example, due to the phthalate plasticizers they contain. Although phthalate-free PVC compounds are available, many device manufacturers are still concerned with the life cycle management of PVC and are seeking alternatives anyway. TPEs can be formulated to look and feel like PVC, but will generally have a broader service temperature range; maintaining flexibility even at sub-zero temperatures.

Classifying TPEs

TPEs are classified by chemical composition: Thermoplastic Olefins (TPE-O), Styrenic compounds (TPE-S), vulcanizates (TPE-V), Thermoplastic polyurethanes (TPE-U), copolyesters (COPE), copolyamides (COPA). Often times, TPEs like polyurethanes and copolyesters, are over-engineered for the application, when a TPE-S or TPE-V would be a more appropriate fit and would also provide a cost advantage.

Conventional TPEs consist of physical blends of rubber and thermoplastic resins, except for thermoplastic vulcanizates or TPE-V's, where the rubber particles are partially or fully cross-linked to improve performance. It is useful to compare the advantages of both types of materials.

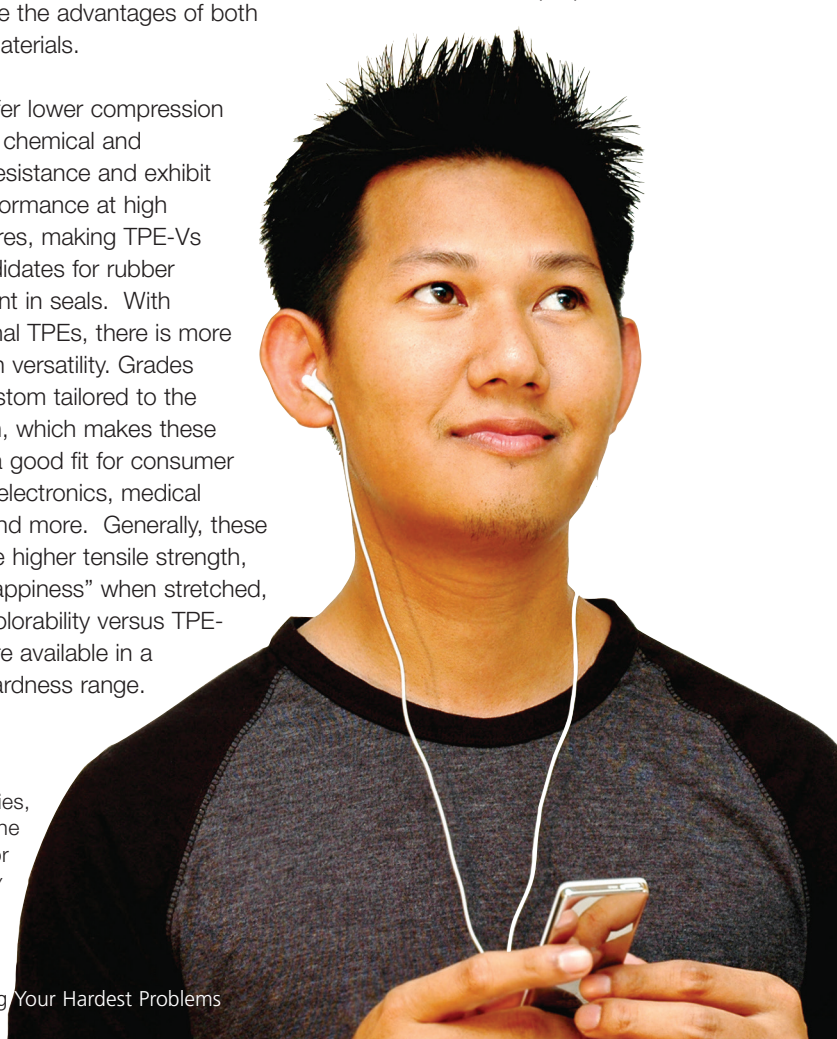
TPE-Vs offer lower compression set, better chemical and abrasion resistance and exhibit better performance at high temperatures, making TPE-Vs good candidates for rubber replacement in seals. With conventional TPEs, there is more formulation versatility. Grades can be custom tailored to the application, which makes these materials a good fit for consumer products, electronics, medical devices, and more. Generally, these TPE's have higher tensile strength, better "snappiness" when stretched, superior colorability versus TPE-V's, and are available in a broader hardness range.

These are the materials that can be formulated to adhere to rigid substrates like PC, ABS, HIPS, Nylon, and more, providing the soft-touch grips on toothbrushes, power tools, and sports equipment for decades.

Enhance the "look and feel" of Consumer Electronics

Technology trends show consumers are rapidly changing the way they use their personal electronic devices, putting higher demands on OEMs to provide new innovations to satisfy their changing preferences. TPEs provide designers with an entire palette of materials that can improve the performance or enhance the functionality of an electronic device.

Monprene® TPEs, for example, can be customized to meet a multitude of aesthetic properties and



The Monprene CE-17000 Series, developed specifically for earphone cables, has unique capabilities for such applications. *Photo courtesy TEKNOR APEX*

	Monprene CE-17000	TPU	Copolyester	PVC
Processability	++	--	-	0
Halogen-free	+	+	+	-
Weight	+	-	-	-
Drapability	+	0	+	0
Cost	0	--	--	++

Typical HVAC Applications for TPE	
• Weather-stripping	• Vibration Control
• Damper blade seals	• Access door gaskets
• Duct/pipe seals	• Condensate tubing
• Spiral ducting	

Sarlink TPV 5765B Oven Aging Results: 135F for 1000 hours	Percentage Retention
Tensile Strength at 100% Strain	95%
Tensile Strain at Break	98%
Shore Hardness	97%

performance characteristics; whatever the consumer wants:

- Surface Finish: From plastic-like feel to highly elastic, rubbery feel
- Surface Friction: From silky smooth and lubricious to a grippy, tactile feel
- Gloss Level: From a glossy finish to a matte look
- Colorability: custom color to match any palette

The Monprene grades for consumer electronics derive from commercially proven TPEs in markets where Teknor Apex has longstanding expertise, such as medical, personal care, and safety products. These products are safe for prolonged use in intimate human contact.

The Monprene CE-17000 Series was developed specifically for earphone cables. These grades exhibit a silky smooth, matte finish and offer improved resistance to chemicals, like sebum oil, sweat, and suntan lotion. Even at very low temperatures, the cable remains flexible and does not exhibit cracking or warping. The Monprene CE-17000 outperforms engineering TPEs and flexible PVC in this application.

Sealing the Gap in HVAC

As previously noted, the rubber component of Thermoplastic Vulcanizates or TPE-V's, is partially or fully cross-linked, resulting in lower compression set than conventional TPEs. Sarlink® TPE-Vs, developed for the automotive industry, are used extensively in sealing systems worldwide. Sarlink exhibits excellent long term stress relaxation characteristics and tensile properties, and is chemical and abrasion resistant, makes it a good candidate for industrial type seals and weather stripping.

Sarlink TPE-Vs outperform PVC in industrial sealing applications. Unlike PVC, Sarlink remains flexible under extreme hot and cold temperatures, which enables the parts to maintain a seal better in harsh environments. TPE-Vs do not shrink or harden like PVC when exposed to long term heat aging. See data table which shows how well Sarlink maintains its physical properties after long-term heat exposure. In addition, TPE-Vs can be coextruded with other materials, providing dual-durometer seals for enhanced functionality.

Hungry for New Food Contact TPEs?

Food grade silicone products are used in a wide range of applications, from spatula blades to seals in commercial ovens. Silicones exhibit superior resistance to heat and chemicals, which is particularly important for oven seals and bakeware. However, for typical food

Sarlink TPE-Vs outperform PVC in industrial sealing applications, including uses in HVACs. *Photo courtesy TEKNOR APEX*

Typical Food Contact Applications for TPE	
• Housewares/kitchenware	• Collapsible colander/bowls
• Spatula blades	• Grips for utensils
• Seals on food saver lids	• Spout on reusable water bottle
• Anti-skid mats and pads	• Appliance seals and tubing

Property	Silicone	Monprene TPE
Soft & Flexible	++	++
Silky surface feel	++	++
Tensile Strength	+	+
Elongation	+	++
Tear Strength	+	++
Density	0	++
Gas Barrier	-	+
Recyclability	-	++
Bondability - Ease of Assembly	-	++
Cost (Material & Process Design)	-	++

contact applications like appliance tubing and seals, housewares, food saver lids, and anti-skid mats and pads, the resistance to high temperatures and harsh chemicals is not required. In these cases, TPEs are not only a more cost effective solution, but in many cases, offer improvements over silicone.

The Monprene RG series of styrenic-based TPEs was developed specifically for these types of food contact applications and other regulated markets such as children's and infants products. These grades comply with US regulations and European directives for food contact and toy safety. The Monprene RG series offers superior barrier properties and improved tear strength and elongation in comparison to Silicone. In addition, these grades exhibit excellent adhesion to polyolefins, using 2-shot molding, ensuring, for example, that the food saver lid maintains a seal or that your comfort grip doesn't slip off your utensil. Monprene TPEs are dishwasher safe, resistant to household chemicals, and can be custom color matched for aesthetic appeal.

5 Tips for Choosing a TPE Supplier

Beyond the choices and applications of TPEs, a crucial decision relates to the supplier of the material. Among key "ingredients":

#1 Look for a supplier with a broad product portfolio who takes a polymer-neutral approach, recommending the right chemistry to fit the application (no over or under engineering). For instance, the Teknor Apex product portfolio covers a wide range of polymer technologies, unlike other compounders who focus on a single chemistry like styrenic TPE or thermoplastic vulcanizates. The company doesn't try to "push" any single product into an application or market because that's all that's offered. Having expertise in a wide range of polymers enables the supplier to recommend the most appropriate product for a designer's or engineer's application, when it comes to price and performance.

#2 Customer intimacy is also key to determining a solid supplier. A supplier needs to ask the right questions and really listen to the customer while translating the end-product's requirements into the right TPE material properties. The TPE supplier needs to know what type of environment the material will be exposed to, understand what the regulatory requirements are for that market, and what performance characteristics are of importance. Every customer interaction is different, depending on whether working with an OEM, a designer or processor and in what stage the client is in with regards to the design cycle. According to Teknor Apex experts, "Our main goal is to determine if there is a fit between our products and what the customer needs,

The Monprene RG series of styrenic-based TPEs, developed specifically for of food contact applications with grades complying with US regulations and European directives for food contact. *Photo courtesy TEKNOR APEX*

and that is achieved by asking the right questions and listening closely."

#3 Another bottom line need is technical support. Customers require quick turnaround on samples quotes, or responses to general questions. A TPE supplier should have a technical staff that can support the customer from ideation to commercialization. This includes technical service engineers who customize formulas to fit the customer's process and application development engineers who work with customers to fine-tune their process to best run the material. Teknor Apex's Application Development Laboratory, for example, provides design and launch support such as non-linear FEA analysis, CAD and MoldFlow simulation software and prototyping equipment that mimics customers' processes. Engineers can help with weight and cost reduction projects. Teknor Apex can provide tools for engineers and the customer to explore ideas, solve production issues and minimize down time for trialing materials.

#4 A good TPE supplier should also have an in-house regulatory team consisting of product safety experts dedicated to global regulatory affairs that ensures the integrity of every raw material and finished good. Regulatory requirements are becoming increasingly more stringent whether the TPE is used in manufacturing medical devices, packaging or consumer products dealing with food contact. Having in-house regulatory experts is paramount to keep up with regulatory changes globally.

Regulatory implications related to product selection are very important. Different countries have different regulatory bodies. Different markets have different regulatory bodies (In North America, for instance, the FDA covers food contact, USP for medical, UL for electrical applications) so the supplier needs to keep current and ensure products consistently pass testing while keeping current with the standards in different world regions.

#5 For many appliance designers and engineers, market reach is also critical. So for a global company with operations in Asia, America and Europe, having local sales and technical support is important. Teknor Apex, for example, is able to support a product designed by an OEM in North America and manufactured by a processor in Asia. In dealing with complex parts designs or manufacturing processes, it is most helpful when the sales and technical representative is witnessing the process firsthand, in order to make the best product recommendations and troubleshoot issues, or just to close the loop.