THERMOPLASTIC ELASTOMERS INDUSTRY IN THE GCC REGION
CONTENTS

Introduction 4

Global thermoplastic elastomers industry 5

Thermoplastic polyolefin elastomers (TPO) 6

GCC thermoplastic elastomer industry 16

Conclusions 21
Thermoplastic Elastomers (TPEs) perform like thermoset rubbers but can be processed using standard thermoplastic processing equipment and techniques. They can be melted, deformed and recycled easily. Due to their improved properties, e.g. ‘soft-touch’, they are replacing thermoplastics and standard elastomers (where higher performing cross linked properties are not required) despite their higher cost. TPEs are mainly used in the automotive industry, construction industries, plastic engineering, wire and cable, and medical applications. They are split into five main groups as displayed in Figure 1.1.

Demand for TPEs was historically focused on the US, the European Union (EU) and Japan, but the first TPE plants will start up in late 2016 and 2017 in the Gulf Cooperation Council (GCC) region.

Introduction

- Rabigh Refining & Petrochemical Company (PetroRabigh) which is owned by Saudi Aramco (37.5%), Japan’s Sumitomo Chemical (37.5%) and the public (25%), is building a TPO plant at Rabigh, Saudi Arabia which is expected to be completed in Q2, 2017. The plant will use the Sumitomo owned ESPOLEX® (superscript please) brand.
- Sadara, a 50/50 joint venture (JV) between Saudi Aramco and Dow Chemical, started up a polyolefin elastomers plant in late 2016 at Al Jubail, Saudi Arabia. Dow, which owns the AFFINITY™ and ENGAGE™ POE brands, will provide the technology used by Sadara.
- Al-Jubail Petrochemical Company (KEMYA), a 50/50 JV between SABIC and Exxon Chemical Arabia, has opened a polyolefin elastomers plant in Jubail.

What follows is a brief overview of the global TPE industry, after which this report will focus on thermoplastic polyolefin elastomers (TPOs).
Thermoplastic elastomers (TPEs) perform like thermoset rubbers, the traditional elastomers, but can be processed using standard thermoplastic processing equipment and techniques. They can be repeatedly melted, cooled, deformed without affecting the product quality and can be recycled easily. TPEs also have a broader range of properties such as high impact resistance, high strength, shrink resistance and superior aesthetic finishes compared to traditional thermoplastics.

In some instances, where the final application does not require the performance of a crosslinked rubber, they can substitute conventional elastomers such as isoprene rubber (IR), polybutadiene (BR), chloroprene (CR), butyl rubber (IIR), styrene butadiene rubber (SBR) or nitrile rubber (NBR) as TPEs are easier and faster to process at a lower cost.

TPEs are split into five main groups as shown in Figure 1.2:

- styrenics block copolymers (SBCs) which consist of polystyrene and rubber blocks
- thermoplastic polyolefin elastomers including thermoplastic vulcanizates (TPVs),
- thermoplastic urethane (TPUs),
- copolyester thermoplastic elastomers (COPEs),
- polyether block amides (PEBAs or COPAs).

They are mainly used in the automotive industry, construction industry, wire and cable and medical applications, and can be processed by injection moulding, blow moulding, thermoforming and extrusion. Growing demand for lightweight, high performance materials in the automotive industry is expected to be the main driver behind TPE demand growth. The second driver is the increasing pressure from regulators to replace PVC with more eco-friendly products such as TPEs in the automotive and construction industries.

**Figure 1.2 Global TPE demand by type, 2016 (estimate)**

<table>
<thead>
<tr>
<th>Elastomer Type</th>
<th>Demand (5.3 million tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBC</td>
<td>39%</td>
</tr>
<tr>
<td>TPO (including TPV)</td>
<td>38%</td>
</tr>
<tr>
<td>TPU</td>
<td>9%</td>
</tr>
<tr>
<td>COPE</td>
<td>6%</td>
</tr>
<tr>
<td>COPA</td>
<td>8%</td>
</tr>
</tbody>
</table>

Source: Nexant
Thermoplastic polyolefin elastomers (TPO)

Advances in catalysis e.g. metallocenes and other Ziegler-Natta catalysts have enabled the production of a wide range of thermoplastic polyolefin elastomers that are generally grouped into the following categories:

- in-situ thermoplastic polyolefin elastomer (TPOs made in the reactor also referred to as r-TPOs)
- compounded TPOs
- polyolefin elastomers (POEs)
- olefin block copolymers (OBCs)
- thermoplastic vulcanizates (TPVs)

The following table summarises their typical composition, key sectors driving their demand and average annual demand growth rate over the last five years.

<table>
<thead>
<tr>
<th>TPOs types</th>
<th>Typical composition</th>
<th>Driving sectors</th>
<th>2011-2016 Average annual growth rate, global in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-situ TPO</td>
<td>20-40% ethylene, remaining mostly propylene + small amount of butene-1 or octene-1</td>
<td>Automotive, construction</td>
<td>3.5</td>
</tr>
<tr>
<td>Compounded TPO</td>
<td>20-40% elastomer (such as EPDM), remaining mostly thermoplastic (such as PP)</td>
<td>Mainly automotive</td>
<td>2.5</td>
</tr>
<tr>
<td>POEs</td>
<td>65-91% ethylene, 9-35% linear alpha olefins (LAOs) or 70-90% propylene, 10-30% ethylene or butene-1</td>
<td>Packaging film, footwear and TPOs</td>
<td>7.1</td>
</tr>
<tr>
<td>OBCs</td>
<td>Polyethylene/ethylene LAO copolymer or polypropylene/ethylene propylene copolymer</td>
<td>Automotive, construction, footwear</td>
<td>7.1</td>
</tr>
<tr>
<td>TPVs</td>
<td>60-70% EPDM, 30-40% PP</td>
<td>Automotive, construction, electronics</td>
<td>6.9</td>
</tr>
</tbody>
</table>

**In-situ thermoplastic polyolefin elastomer**

**Demand**

An in-situ TPO (also referred to as a reactor TPO) is defined as a polyolefin material containing between 10 and 40% ethylene as produced in the reactor with the remaining composition being mostly propylene.

- Small amounts of additional co-monomers, such as octene-1 or butene-1, may also be present, so as to provide unique functionality.
- The majority of in-situ TPOs are between 20 to 40 weight percent ethylene as polymers with less than 20% ethylene are fairly hard and usually have poor elastomeric properties; these are classified as impact polypropylenes. Polymers containing greater than 40% ethylene are quite soft and have relatively poor elastomeric properties.
In-situ TPOs compete to some extent against compounded TPOs (detailed in the next sub-section). However, high elastomer content in-situ TPOs are difficult to produce and high levels of other additives, especially colorants such as carbon black, must still be added. This has largely relegated in-situ TPOs to applications with either low ethylene content, or where dispersing other ingredients can be done easily during fabrication. In-situ materials are used to reduce cost and increase the end use value in cases where the TPO does not need to be compounded prior to fabrication. Displacement of compounded TPOs by in-situ materials appears to have largely run its course.

The main application of in-situ is automotive exterior and bumpers, impact modifiers, interior head impact trim, under-the-hood impact, cladding, wire harness, and weather strip followed by construction roofing applications.

**Demand by region**

Global demand in 2016 is estimated at 414,000 metric tons, as shown in Figure 1.3 and Table 1.2.

Global in-situ TPO growth averaged 3.5% between 2011 and 2016, while North American demand increased as the automotive sector and residential construction sector recovered. Growth in Western Europe and Japan has been slow due to weak economic conditions and the progressive automotive industry relocation as production of fabricated parts moves to lower labour cost regions such as Central and Eastern Europe and the rest of Asia, China and India in particular.

| Table 1.2 In-situ TPO AAGR by region, 2011-2016 (thousand tons per year) |
|-------------------------|-------------------------|-------------------------|
|                        | 2011 | 2016 | Annual average growth rate, % (2011-2016) |
| North America          | 126  | 156  | 4.4 |
| Western Europe         | 129  | 138  | 1.4 |
| Japan                  | 43   | 48   | 2.4 |
| GCC                    | 6    | 10   | 10.0 |
| Rest of the world      | 44   | 62   | 7.1 |
| **Total**              | 348  | 414  | 3.5 |
Demand by application
Currently, automotive applications remain the largest outlet for in-situ TPOs, accounting for an estimated 75% of global demand. End uses are dominated by safety features, such as interior head impact trim, under-the-hood impact areas, and cladding.

In-situ TPOs are used in engine compartments and under-the-hood parts, such as carburettor air ducts, wiring harness sleeves, heating air ducts, conduits, hood seals, fire wall pads, and fender liner pads.

Other applications include building/roofing, food packaging and medical applications.

In-situ TPOs are gaining share in building and construction applications, which now account for 15% of global demand. They have also become prominent in new flame retardant roofing applications. TPO roofing membranes combine attributes of flexible single-ply membranes EPDM and PVC. These attributes include long term weathering resistance, cold temperature flexibility, tear resistance, puncture resistance, chemical resistance and heat seaming capability. In addition, since TPOs are a true thermoplastic material, they do not cure after exposure to the elements, and they remain hot air weldable throughout their service life.

Miscellaneous other applications account for 10% of the global market and include medical fluid bags and bottles, food packaging wrapping film, shrink film, sealants, wire and cable.

Application growth
Automotive applications will continue to dominate in-situ TPO end uses. The automotive outlook continues to look bright, due to the decision made by numerous companies to phase out the use of PVC in automobile interiors. Trends to gradually reduce the number of different plastics in the automobile interior favour in-situ TPOs.

Global in-situ TPO demand growth is expected to exceed the growth of the automotive industry as TPO progressively substitute lower end products.

Supply
LyondellBasell has been the leader in in-situ TPO production with a diverse portfolio as a result of its strong position in polypropylene technology, and subsequent extension of this technology position into compounded TPO products. The other main producers include INEOS, Borealis, Japan Polypropylene, Prime Polymers and ExxonMobil.

Compounded thermoplastic polyolefin elastomer
Broadly speaking, a compounded TPO is defined as a mixture of an olefinic semi-crystalline thermoplastic and an amorphous elastomer, i.e. a rubber. The blends are prepared in a post polymerization step by mixing the hard polymer and elastomer together in compounding equipment such as a mixer. The relative proportions of polyolefin, mainly polypropylene, and rubber can vary, but compounded TPOs typically contain 20 to 40 weight percent elastomers.
The elastomeric phase can contain rubbers such as ethylene propylene diene monomer (EPDM), ethylene propylene rubber (EPR), polyolefin elastomers and olefin block copolymers (defined in the next section).

By far, the most commonly available compounded TPOs are mixtures of polypropylene (particularly impact copolymer polypropylene) and EPDM rubber or polyolefin elastomer. Compounded TPO products cover a wide range of properties that essentially bridge the gap between soft rubber and engineering plastics. They can be formulated to combine strength and toughness with properties and feel from soft traditional rubber to stiff products with high impact strength. Their main use is in automobiles, interiors and under the hood parts, and exterior trims. They are also used in appliances parts and sheets.

Demand

Demand by region
Global compounded TPO growth averaged 2.5% between 2011 and 2016. Global demand in 2016 is estimated at 692,000 metric tons, as displayed in Figure 1.5 and Table 1.3.

The shift in end product manufacturing to low-wage Asian countries, notably China, has slowed compounds growth, especially in non-automotive applications in North America. However, the repatriation of the manufacturing industry due to shale gas development is expected to drive the domestic demand in the coming years. Western Europe and Japan’s domestic demand growth is slow due to shifts in original equipment manufacturing to Eastern Europe, China and India as well as the relatively weak domestic automotive industry.

Table 1.3 Compounded TPO AAGR by region, 2011-2016 (thousand tons per year)

<table>
<thead>
<tr>
<th>Region</th>
<th>2011</th>
<th>2016</th>
<th>Annual average growth rate, % (2011-2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>175</td>
<td>208</td>
<td>3.5</td>
</tr>
<tr>
<td>Western Europe</td>
<td>268</td>
<td>279</td>
<td>0.8</td>
</tr>
<tr>
<td>Japan</td>
<td>93</td>
<td>98</td>
<td>1.1</td>
</tr>
<tr>
<td>GCC</td>
<td>16</td>
<td>24</td>
<td>8.6</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>59</td>
<td>83</td>
<td>7.2</td>
</tr>
<tr>
<td>Total</td>
<td>611</td>
<td>692</td>
<td>2.5</td>
</tr>
</tbody>
</table>
Demand by application
Main applications are in the automotive sector, building and roofing. Growth in automotive is partly a result of increased car builds and of polypropylene consumption per car. Volumes for interior applications continue to grow, while demand for exterior applications remains relatively constant. Compounded TPO products are being promoted to replace flexible PVC in instrument panel coverings and other interior applications.

- Interior trim compounded TPO applications include door panels, seat trim, seat backs, headrests, armrests, consoles, instrument panels, rear electrical shelf tray, airbag covers, and more. The majority of these parts are all moulded in colour, eliminating any costly secondary operations. Furthermore, compounded TPOs provide superior impact resistance allowing for the integration of energy parts for air bag deployment at the lowest system cost possible. Compounded TPOs stand to gain additional interior applications due to cost and material consolidation/recyclability issues. Consequently, as compounded TPOs replace ABS and PC/ABS blends, they will find increasing acceptance in applications such as kick panels.

- TPOs account for most of the airbag cover market, with the largest growth seen in Asia. They continue to replace styrenic TPEs (SBCs) in this application as they are easier to process and are lower in cost. One reason is better airbag deployment by TPOs at minus 40 °C. Moreover, as airbags continue to proliferate in the interior compartment (e.g., side curtain, side impact), more and more parts are in their deployment paths and thus require ductile impact failure. Foamed TPOs continue to replace foamed polyurethanes in steering wheels and seatbelt refractors. This is because of the lower prices, better paintability, and improved cosmetic look as seals are less obvious.

- Other miscellaneous automotive end uses include light gaskets, glass channels, central cable covers, steering wheel/column covers and some flexible trim. TPO compounds are also used as sound barriers to absorb the noise of air conditioner systems, and as speaker box enclosures.

Penetration of compounded TPOs into other end uses has been slow which can be attributed to factors such as insufficient compression set properties when compared to vulcanized rubbers. Major non-automotive TPO applications are low voltage wire and cable, and extruded hoses and tubes. TPOs are generally specified over TPVs in wire and cable due to lower cost combined with good electrical properties, weatherability, and temperature range. Compounded TPOs also have small end uses in the medical and sealants sectors.

Application growth
Most compounded TPOs are mature in their end uses as well as in their formulations since TPO technology has become widespread. However, there is room for innovation as Original Equipment Manufacturers (OEMs) and customers continue to request new properties and performance attributes.

TPO based membranes are increasingly used in buildings for water proofing systems due to its easy laying, welding and durability.

Supply
The majority of the compounded TPO capacity is concentrated in developed regions such as North America, Western Europe, and Japan. The North American market has a large number of independent compounded TPO producers, with few integrated producers. LyondellBasell and ExxonMobil have integrated polypropylene production and compounding operations. ExxonMobil is back integrated with EPDM production as well. In Western Europe, the compounded TPO business is dominated by integrated producers such as LyondellBasell, ExxonMobil, and Borealis. The strong participation of the integrated producers result in higher operating rates for polypropylene compounding, compared to North America. In Japan,

Figure 1.6 Compounded TPO by end use market, 2016 (estimate) (692,000 tons)

<table>
<thead>
<tr>
<th>End Use Market</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>80%</td>
</tr>
<tr>
<td>Building and construction</td>
<td>13%</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>7%</td>
</tr>
</tbody>
</table>

Source: Nexant
Mitsubishi Chemical and Sumitomo Corporation are integrated compounded TPO producers, while Riken Technos is an independent producer. In general, polypropylene compounding industry is integrated in Japan.

Due to the safety issues, the automotive manufacturers are concerned with the quality and performance of the raw materials. They prefer to discuss required quality and performance issues directly with the resin producers, who are more capable of modifying resin properties and assuming product liability risks than the independent compounders.

Polyolefin elastomers (POES) and olefin block copolymers (obcs)

Polyolefin elastomers (POEs) are split into two categories.

- POEs based on ethylene typically contain about 65% to 91% ethylene and 9% to 35% octene-1, hexene-1 or butene-1. These are generally made from LDPE.
- Propylene-based elastomers typically contain 70% to 90% propylene and 10% to 30% ethylene or butene-1.

Ethylene-based POEs have better crosslink ability and better low temperature performance than propylene based POEs.

These products are generally produced via metallocene or constrained geometry catalysts and are finding use as the elastomeric portion in TPOs, or as polymer modifiers.

All compounded TPOs were formerly PP/EPDM blends. However, POEs have rapidly displaced EPDM, in many compounded TPOs. Additional displacement of EPDM is projected on the basis of the ability to better tailor end use properties (the POEs are made with metallocene catalysts and thus their properties can readily be tailored), ease of handling (POEs are in pellet form, whereas EPDM is typically baled), and lower overall cost (bales are more labour intensive to use than pellets).

A product of advancements in polymerization catalyst technology, POEs material was originally slated for use in improved flexible packaging films. POEs are now also used as low-cost rubber replacements for some non-demanding moulded goods applications, those that will not be exposed to extremes in temperatures, pressures, loads or stress environments. In moulded goods, POEs are being used where a degree of flexibility or tactile feel is desired.

Olefin block copolymers (OBCs) are polyethylene/ethylene alpha olefin copolymer blocks or isotactic polypropylene/ethylene propylene copolymer multi block copolymers, characterized by hard and soft blocks differing in their properties, either chemical or physical. The blocks may differ in the amount of type of incorporated comonomer, density, amount of crystallinity, amount of branching, homogeneity or some other physical property.

The olefin block copolymer market is small and has been estimated along with POE since both elastomers serve the same market to a large extent, such as compounded TPOs.

Demand

Demand by Region

Global 2016 POE demand is estimated at 637 000 metric tons, as shown in Figure 1.7 and Table 1.4. Globally, POEs have displaced EPDM content to a certain extent in compounded TPOs. Penetration is however slowing, as some TPOs will continue to require EPDM to reach the desired elastomeric properties.

Figure 1.7 POEs by region, 2016 (estimate) (637,000 tons)

<table>
<thead>
<tr>
<th>Region</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>30%</td>
</tr>
<tr>
<td>Western Europe</td>
<td>23%</td>
</tr>
<tr>
<td>Japan</td>
<td>9%</td>
</tr>
<tr>
<td>GCC</td>
<td>2%</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>36%</td>
</tr>
</tbody>
</table>

Source: Nexant
Table 1.4 POEs AAGR by region, 2011-2016 (thousand tons per year)

<table>
<thead>
<tr>
<th>Region</th>
<th>2011</th>
<th>2016</th>
<th>Annual average growth rate, % (2011-2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>130</td>
<td>191</td>
<td>8.0</td>
</tr>
<tr>
<td>Western Europe</td>
<td>114</td>
<td>148</td>
<td>5.3</td>
</tr>
<tr>
<td>Japan</td>
<td>44</td>
<td>56</td>
<td>5.1</td>
</tr>
<tr>
<td>GCC</td>
<td>8</td>
<td>15</td>
<td>13.4</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>156</td>
<td>227</td>
<td>7.8</td>
</tr>
<tr>
<td>Total</td>
<td>452</td>
<td>637</td>
<td>7.1</td>
</tr>
</tbody>
</table>

North America is the largest market for POEs, followed by Western Europe. GCC demand for POE is also expected to grow given the infrastructure developments in the region. Asia Pacific represents the fastest growing market, particularly China. China has a large demand for compounded TPO due to the presence of a strong automotive industry.

**Demand by application**

The polyolefin elastomers based on ethylene and propylene serve the same markets to a large extent. Propylene based elastomers are being used as the elastomeric phase in the compounded TPO as they impart impact strength to polypropylene.

In North America and Western Europe, compounded TPO is the largest market for butene-1 and octene-1 based POE, accounting for over half of the market. The main application is the fabrication of auto parts.

Polymer (impact) modification is the fastest growing end use for POEs. POEs are used as polymer modifiers in a wide range of products including sheeting, packaging film (as the seal layer) and medical goods. Additionally, polymer modification of EVAs for footwear is an important end use in Asia.

Other POE applications include foam, blow moulding, sheeting, building and construction, other extrusion and footwear such as trainers and flip flops. POEs have a sealing temperature advantage in packaging and rigid packaging applications.

Figure 1.8 Global POE demand by end use (estimate) (2016)

- Compounded TPOs: 51%
- Polymer modification: 29%
- Wire and cable: 10%
- Other: 10%

Source: Nexant
Application growth
POE growth markets also include wire and cable, displacing PVC and to a lesser extent EPDM. In view of the European legislation, there are a growing number of wire and cable applications requiring the use of halogen free or non-PVC insulation or sheathing materials. This has led to the growth of halogen free flame retardant formulations based on the use of ethylene copolymers and hydrated fillers. The use of POEs in the halogen free flame retardants (HFFR) formulation, makes HFFR become more flexible and decreases hardness.

Olefin Block copolymers are being used as a replacement for EPDM rubber in the compounded TPOs, as well as EVA in the shoe soles.

Supply
ExxonMobil and Dow account for more than 50% of the global capacity for polyolefin elastomers currently. Most POE plants are built such that they can swing and produce multiple grades of elastomers such as POE based on ethylene, propylene-based elastomers, OBC (Dow only), and LLDPE.

Polyolefin elastomers production technology is held by a handful of companies such as Dow, ExxonMobil, Mitsui, LG Chem, and SABIC SK Nexlene Company (SSNC, 50/50 JV between SK Global Chemical and SABIC (which owns the Nexlene™ solution technology). These companies are not known to license their technologies to other companies for polyolefin elastomers production, but produce elastomers in joint ventures with other companies.

Commercially, olefin block copolymer elastomers are produced by Dow only.

Thermoplastic vulcanizates (TPVs)
TPVs are blends of elastomers, typically rubbers such as EPDM, EPR, SBS, polybutadiene (BR) or butyl rubber (IR) dispersed in a relatively small amount of thermoplastic matrix, typically polypropylene or polyethylene. However, polyamides, copolymers of styrene and acrylonitrile, ABS, polycarbonates, polystyrene can also be used in the thermoplastic matrix of the EPDM.

Thermoplastic vulcanizates (TPVs) typically contain 60% to 70% EPDM and 30% to 40% impact polypropylene.

These products contain a low level of crosslinks but are true thermoplastic materials. TPVs 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.

Demand
Demand by region
TPVs have historically grown at the expense of thermosets and continue to replace thermoset rubbers in the automotive applications, with automotive seals being the largest growth driver. Global TPV demand is estimated at 293,000 tons in 2016, as shown in Figure 1.9 and Table 1.5.

Figure 1.9 TPVs by region, 2016 (estimate) (293,000 tons)

<table>
<thead>
<tr>
<th>Region</th>
<th>Demand (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>33%</td>
</tr>
<tr>
<td>Western Europe</td>
<td>24%</td>
</tr>
<tr>
<td>Japan</td>
<td>15%</td>
</tr>
<tr>
<td>GCC</td>
<td>5%</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>23%</td>
</tr>
</tbody>
</table>

Source: Nexant
Table 1.5 TPVs AAGR by region, 2011-2016 (thousand tons per year)

<table>
<thead>
<tr>
<th>Region</th>
<th>2011</th>
<th>2016</th>
<th>Annual average growth rate, % (2011-2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>62</td>
<td>97</td>
<td>9.5</td>
</tr>
<tr>
<td>Western Europe</td>
<td>59</td>
<td>72</td>
<td>4.0</td>
</tr>
<tr>
<td>Japan</td>
<td>35</td>
<td>44</td>
<td>4.7</td>
</tr>
<tr>
<td>GCC</td>
<td>7</td>
<td>14</td>
<td>12.9</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>47</td>
<td>66</td>
<td>7.2</td>
</tr>
<tr>
<td>Total</td>
<td>210</td>
<td>293</td>
<td>6.9</td>
</tr>
</tbody>
</table>

The demand growth averaged 6.9% between 2011 and 2016. Global demand for TPVs is concentrated in North America, Western Europe and Japan, reflecting their leading status as centres for car production. Growth is expected in the automotive industry in Asia, particularly China and India. The Central and East European market is also growing fast as French and German manufacturers are relocating outside Western Europe.

Demand by application
The automotive sector is the largest end use market for TPVs, accounting for approximately 50% of global demand in 2016. The automotive industry was one of the first to exploit the cost/performance advantages of TPVs, replacing thermoset rubbers such as SBR, EPDM, and chlorosulfonated polyethylene. Continuously increasing under the hood temperatures, and ongoing emphasis on safety, reliability, low maintenance and low total cost of parts manufacture are all trends that have favoured the use of TPVs in this market. Typical TPV applications in automotive include hose coverings, air inlet duct covers, gaskets, seals, convoluted boots, vibration dampeners, bushings, strut covers, ignition components, and window seals. TPV flexible automotive under-the-hood components include air intake tubes and bellows, steering system bellows, wheel well flares, and sound abatement parts.

Automotive end uses account for a larger percentage of TPV demand in Japan than in North America or Western Europe, notably due to the Japanese OEMs, such as Toyota, Honda, Mitsubishi, Mazda, and Nissan.

Figure 1.10 Global TPV demand by end use (estimate) (2016)

![Figure 1.10 Global TPV demand by end use (estimate) (2016)](image-url)
Major non-automotive TPV applications are building and construction, extruded hose and tube, and wire and cable. Building and construction applications include sheeting/film, weather stripping, sky-light gaskets, profile extrusions, and expansion joints. Competing products include PVC, HDPE, and chlorosulfonated polyethylene.

In the wire and cable sector, TPVs compete with several high-performance thermosets such as polychloroprene. Penetration of the thermoset rubber wire and cable industry has proven difficult, as specifications are frequently written around thermoset rubbers.

The consumer market is an emerging sector for TPVs with their soft feel and non-slip as key properties. They are being used increasingly in houseware products, toys, power/hand tools, and in personal care products such as toothbrushes, hairbrushes and razors.

Application growth

Growth of TPVs in automotive is projected to be strong, as TPVs are set to penetrate numerous automotive weather seal applications at the expense of thermosets. Cost is the biggest advantage, with TPVs 10% to 30% lower than EPDM, along with lower weight, improved design flexibility, and recyclability.

Supply

The production of TPVs is dominated by few producers including ExxonMobil Chemical, Teknor Apex, Mitsui, and Sumitomo, though few other smaller players exist. Most of these major players are integrated with raw materials, especially for EPDM, and offer a variety of grades suitable for different applications.

Closest to the Middle East, Turkey is reported to have compounding facilities which can produce TPVs. Elastron Kimya and Enplast are amongst the leading producers in the country. These producers typically manufacture a variety of compounding plastics and elastomers supplying to local and regional markets as well as exporting to European market.
GCC thermoplastic elastomer industry

New thermoplastic elastomer plants in the GCC

The TPO plants under construction in the GCC are all in Saudi Arabia and detailed below.

PetroRabigh (Saudi Aramco/Sumitomo)

PetroRabigh Refining & Petrochemical Company (PetroRabigh) is a Saudi Arabia based company owned by Saudi Aramco (37.5%), Japan’s Sumitomo Chemical (37.5%) and the public (25%). PetroRabigh operates a refinery as well as a cracker, PE, PP, propylene oxide, ethylene glycol and butene-1 plants since 2009 at Rabigh, Saudi Arabia.

The company started a phase II expansion project in 2009, which includes ethane cracker expansion as well as additional products such as thermoplastic polyolefins (TPO), ethylene propylene rubber, methyl methacrylate monomer, polymethyl methacrylate, low-density polyethylene/ethylene vinyl acetate, para-xylene/benzene, cumene and phenol/acetone.

The complex is expected to be completed in Q2, 2017. The phase II investment cost is currently estimated at USD 8.3 billion.

The JV did not disclose its planned capacity or the thermoplastic polyolefins grades to be produced but Nexant understands that Sumitomo’s technology will be used. Sumitomo owns the ESPOLEX™ (Polyolefinic Thermoplastic Elastomer, TPE Series) brand which is used mainly for automotive applications, automotive exteriors and interiors, engine compartment, automotive plastics modifiers, airbag cover, as well as for home appliances and electronics (white goods, TVs, PCs). Sumitomo can produce at least 15 main ESPOLEX™ grades split into the flexible, semi-flexible or rigid categories. Those products can be used for injection moulding (3000 series and 900 series) or extrusion moulding (4000 series and 800 series).

ESPOLEX™ competes against SBR, chloroprene, chlorosulphonated polyethylene, crosslinked polyethylenes and PVC where the thermoplastic polyolefins benefit from a larger range of service temperature.

Sadara Chemical Company (Sadara) is a joint venture developed by Saudi Aramco and The Dow Chemical Company. Established in 2011 in Jubail Industrial City II, Saudi Arabia, Sadara is the largest chemical complex ever built in a single phase, with an investment of USD 20 billion. It will comprise 26 processing units which will produce more than 3 million metric tons per year of differentiated chemicals and plastic products, including LDPE, LLDPE, HDPE, polyolefin elastomers (POE), polyurethanes (isocyanates and polyether polyols), propylene oxide, propylene glycol, glycol ethers and amines, among others. The first plant started up in December 2015, and the rest of manufacturing plants are undergoing a phased commissioning and start-up process.

The polyolefin elastomers will go into consumer goods, membranes, transportation, and building and construction applications.

The JV did not disclose its planned capacity or the thermoplastic polyolefins grades to be produced but Dow’s technology will be used for Sadara. Dow owns the AFFINITY™ and ENGAGE™ POE brands.

- AFFINITY™ is made with ethylene and LAO (11 grades available).
- ENGAGE™ POE is made with ethylene and octene-1 (23 grades available) or ethylene and butene-1 (12 grades available).
- The AFFINITY™ applications include food packaging while the ENGAGE™ brand targets automotive applications, such as interior, roofing and bumper, as well as wire and cable coatings, footwear, toys and household products.

Dow also manufactures other elastomer types such as EPDM, olefin block copolymers and plastomers. These are currently manufactured in the USGC, Spain and Thailand only.

KEMYA (SABIC/ExxonMobil)

Al-Jubail Petrochemical Company (KEMYA) is a 50/50 joint venture between Saudi Basic Industries Corporation (SABIC) and Exxon Chemical Arabic, an affiliate of ExxonMobil Chemical. KEMYA produces ethylene, propylene, low density polyethylene and linear low density polyethylene at Jubail, KSA.
SABIC and ExxonMobil have begun construction of a new elastomers plant with a total investment cost of USD 3.4 billion. The units could start in late 2016 and will have the capacity of about 400,000 tons per year of synthetic rubber such as:

- thermoplastic elastomers (the plant will produce POEs)
- butyl rubber (IIR)
- polybutadiene (BR) and styrene butadiene rubber (SBR)
- ethylene propylene diene monomer (EPDM) rubbers
- carbon black (rubber grades, this plant started up in April 2016 with a capacity of 50,000 tons per year)
- elastomers compounding plant

The announced KEMYA grades are as follows:

- polybutadiene (BR)
  - SABIC® BR4010, BR4610 and BR5510—tyre (treads, sidewalls, bead, skim coats), industrial products, footwear and others
- ethylene propylene diene monomer (EPDM) rubbers
  - SABIC® EPDM 657 — general purpose hose, weather seals, industrial hose, wire and cable
  - SABIC® EPDM 626 — roof sheeting, flexible pond liners and geomembranes
  - SABIC® EPDM 756 — weather seal, auto coolant/air hose, industrial hoses, wire and cable
  - SABIC® EPDM 855 — industrial gaskets, Profiles, O rings for pipe/hose, washing machine gaskets
  - SABIC® EPDM 245 — brake parts, auto coolant/air hoses, industrial gaskets/O rings

Figure 1.11 GCC TPO target markets

Source: Nexant

Thermoplastic Elastomers Industry in the GCC Region | 17
GCC TPO plants target markets

Dow and Saudi Aramco indicated that Sadara’s range of products would target principally Asia Pacific, the Middle East and Europe, while KEMYA and PetroRabigh plan to target principally the Middle East and Asia.

The following section reviews the GCC growth drivers in the main TPO end use sectors.

Growth drivers in the GCC

The main TPO end uses are in the transportation/automotive sector followed by the construction industry, packaging applications, the production of consumer appliances as well as the medical, pharmaceutical and cosmetics sector.

The growth drivers for those sectors are detailed below.

Transportation/automotive

Demand in the automotive industry in the GCC region is expected to grow by six percent per year on average over the next five years as the population increases rapidly and benefits from high disposable incomes combined with access to vehicle financing and low petrol prices compared with other regions.

The GCC region already has the highest ratio of cars to households in the world, thus the average age of cars is expected to increase. This will lead to a growing demand for spare parts.

In addition, public transport infrastructure continues to be developed in the region, which will also boost demand for heavy trucks and commercial vehicles.

Saudi Arabia and the UAE are the largest automotive markets in the GCC region. The local demand is for spacious high end cars from Asian (such as Toyota, Hyundai and Kia) or US (such as Chrysler, Ford and GM) brands. Ninety percent of the demand is met by imports as vehicle manufacturing in the region tends to be limited to assembly lines such as Daimler/National Automotive Industry at Jeddah, Volvo Truck/Zahid Tractor and Heavy Machinery at King Abdullah Economic City, MAN/Hajji Husein Alireza at Jeddah and Isuzu Motors truck assembly line at Dammam.

In Saudi Arabia, the National Industrial Clusters Development Program (NICDP) aims to expand and diversify Saudi Arabia’s manufacturing sector. It has established an automotive cluster to produce cars and spare parts locally. The cluster has already had a positive impact on the local automotive industry. Recent announcement regarding automotive investment projects include:

- Saudi Malaysian Industrial Development Holding Company 300,000 Meeya per year by 2017 in Dammam
- Saudi National Automobile Manufacturing Company (SNAM)/Daewoo (assembly of 150,000 cars per year at Sudair Industrial City by 2018)
- Isuzu plans to manufacture 25,000 light and heavy-duty trucks by 2018 in Dammam

Those projects will be supported by the development of a local aluminium industry. Saudi Arabia Mining Company (Ma’aden) and Alcoa have been operating a low cost aluminium smelter at Ras Al Khair since December 2014 which provides competitively priced aluminium for use in vehicle production. The drive for lightweight vehicles is expected to benefit to the TPE market.

The UAE does not produce vehicles and relies on imports. The market is divided between passenger cars 80% and commercial vehicles 20%.
Construction

While the automotive industry was only mildly impacted by the oil prices slump, the construction sector has slowed down since 2014 as GCC governments have had to delay or cancel costly infrastructure projects. The following mega projects were put on hold:

- The GCC railway project, a long distance rail network aiming to connect Oman, the UAE, Saudi Arabia and Bahrain, was halted in 2016.
- The Darb Al Sunnah walking track project in Saudi (halted in November 2015).
- The Integrated Facilities Expansion project in the UAE (halted in 2016).

As a result of the economic slowdown, construction companies had to cut their workforce.

However, infrastructure projects for the Dubai World Expo in 2020 and the Qatar World Cup in 2022 will go ahead as planned. Governments also indicated that they will continue to spend on infrastructure such as roads, public transport infrastructure, power generation, health care, schools, hospitality (hotels and tourism facilities) and housing as population continues to grow rapidly and plans to diversify the mainly oil-based GCC economy require continued investments. Recent large project awards are listed below.

- In 2016, Hanwha Engineering & Construction, Daewoo Engineering & Construction and Saudi Pan Kingdom for Trading & Contracting (SAPAC) won a USD 20 billion housing project to supply 100,000 houses and city infrastructure in Alfursan near the Riyadh International Airport in Saudi Arabia. The Saudi Ministry of Housing plans to build 1.5 million housing units over the next seven years.
- The King Abdul Aziz Road project in Mecca, Saudi Arabia which was awarded to Dallah Albaraka (USD 6.1 billion). Completion is expected in 2025.
- Alba Sixth Potline Expansion to boost the smelter’s capacity (USD 3.5 billion, scheduled for completion in 2019) in Bahrain.
- LNG Import Terminal in Al-Zour, Kuwait (USD 3 billion, scheduled for completion in 2020).
- Sohar 3 – Iibri Independent Power Plant in Oman (USD 2.3 billion, scheduled for completion in 2019).
- Royal Atlantis Resort on the Palm in Dubai, UAE (USD 1.4 billion, completion in 2017).

The construction industry is expected to decline by around 12% in 2016 compared with 2015 levels but is forecast to grow at GDP levels in the medium term assuming oil prices recover.

Packaging

In the GCC, it is anticipated that the plastic packaging industry will grow by an average of 6% over the next five years. The main drivers are rising incomes and urbanization, a young and growing population, the development of the retail infrastructure (supermarkets are gaining market shares from artisan/independent stores) with the growing penetration of pre-packaged foods for convenience and a better product integrity.

In addition, plastic packaging continues to substitute metals, glass, and paper/paperboard given its attractive price and property relationships, as well as generally easy recyclability, low weight and design flexibility.

This demand growth will be supported by new polyolefin and elastomer capacity additions (such as Sadara, KEMYGA and
PetroRabigh) in the GCC region which will add higher end polymers enabling the manufacture of more complex packaging products such as long shelf life products. In particular, the Royal Commission for Jubail and Yanbu (RCJY) and Sadara developed the PlasChem Park in Jubail Industrial City II. Park tenants will receive products from Sadara or other Jubail petrochemical producers for further conversion to finished or semi-finished products in the packaging sector as well as construction materials, paints and coatings, home and personal care sectors.

Saudi Arabia accounts for about 75% of the GCC plastic packaging industry with the UAE and Kuwait being the other main regional players.

**Consumer appliances**

Demand for consumer appliances, such as refrigerators, washing machines, cooking appliances, etc. is expected to grow by around 6% per year over the next five years in the GCC region. The main drivers are expected to be the population growth coupled with housing development as well as appliances replacement.

**Pharmaceutical, medical and cosmetics**

**Pharmaceuticals**

The GCC pharmaceutical market currently stands at around USD 9.6 billion and is expected to grow by 9% per year on average over the next five years. Main drivers include population and income growth, ageing population, incidence of lifestyle diseases and health care standards.

Around 85% of pharmaceutical products are currently imported and medicines are costly compared with international standards, thus counterfeit goods are common. GCC governments have tried to promote local production in order to diversify their economies. Most drugs manufacturers are in Saudi Arabia and the UAE. There are around 15 to 20 pharmaceutical manufacturers in Saudi Arabia such as SPIMACO, Jamjoom Pharma, Tabuk Pharmaceuticals and Jazeera Pharmaceutical Industries.

Generics currently account for only 7% of the total GCC pharmaceutical market compared with 80% in the US for prescription drugs. As prescription drugs account for around 85% of the pharmaceutical sector in the GCC region, the production of generics is expected to increase faster than production of under license pharmaceuticals in the region.

**Medical/Healthcare**

As detailed in the construction section, the GCC continues to invest in infrastructure including medical facilities such as clinic and hospitals. In addition, Saudi Arabia plans to extend mandatory private health insurance potentially starting with the education sector in 2017. This is expected to increase the healthcare/medical market from around USD 45 billion in 2016 to USD 70 billion in 2020, with an average annual growth rate of 11.5% over the next five years.

**Cosmetics**

The GCC cosmetics market currently stands at around USD 10.3 billion and is expected to grow by 8% per year on average over the next five years. Spending on cosmetics per capita is the highest in the world as the GCC region benefits from a young and wealthy population. The bulk of the demand comes from Saudi Arabia and the UAE which account for 72% of the GCC demand. Fragrance represent nearly a third of the demand followed by haircare and skincare, both accounting for over ten percent of the market.
Conclusions

Thermoplastic elastomers (TPEs) have an excellent balance of performance and price and are replacing both conventional thermoplastics and standard elastomers.

Thermoplastic Polyolefin Elastomers (TPOs) is the second largest TPE category and accounts for 38% of the total TPE demand. It includes the polyolefin elastomers (POEs) and thermoplastic vulcanizates (TPVs) sub-categories.

- Global POE demand growth averaged 7.1% between 2011 and 2016 compared with a growth rate of 13.4% in the Gulf Cooperation Council (GCC) region over the same period.
- Global and GCC region TPV consumption increased respectively by 6.9% and 12.9% over the last five years.
- The first TPO plants are expected to start up in late 2016 in the GCC region.
- Rabigh Refining & Petrochemical Company (PetroRabigh) is building a TPO plant at Rabigh, Saudi Arabia.
- Sadara is expected to start up a POE plant at Al Jubail, Saudi Arabia.
- Al-Jubail Petrochemical Company (KEMYA) has begun construction of a POE plant at Al Jubail, Saudi Arabia.

The main TPO end uses are in the automotive sector followed by the construction industry, packaging applications, the production of consumer appliances as well as the medical, pharmaceutical and cosmetics sector. Demand in those sectors is expected to grow by 6 to 12% per year on average over the next five years in the GCC region as the population increases rapidly and benefits from high disposable incomes requiring investments in infrastructure, from mega projects to housing, healthcare and transportation.

Further information on thermoplastic elastomers can be found in Nexant’s Thermoplastic Polyolefin Elastomers Process Evaluation/Research Program. Contact Anna Ibbotson, (aibbotson@nexant.com) a Principal in Nexant’s Energy and Chemicals Advisory (ECA) practice.

For questions related to this brochure, please contact David Lines (dlines@nexant.com), a Bahrain-based Nexant Principal in the ECA practice.

Nexant is an independent international energy consulting company that provides expertise in areas such as strategy and business planning, master planning or feasibility studies, techno-economic and commercial analyses, transaction related support and financial evaluation. For more details on Nexant’s capabilities, please refer to Andrew Spiers (aspiers@nexant.com) who holds the position of Senior Vice President, Middle East.

About Nexant

Nexant Energy & Chemical Advisory Services offers clients a suite of products and advisory services with an exclusive focus on the energy, chemicals, and related industries. Using a combination of business and technical expertise, with deep and broad understanding of markets, technologies and economics, we provide solutions that these industries have relied upon for over 45 years. Services include Strategic Investment Studies, Market and Technical Due Diligence, Strategic Growth Plans, Independent Engineering, Project Feasibility Studies, Industry Analytics, Forecasting and Market Research, Litigation Support and Expert Testimony. NexantThinking report subscription programs and online product portal, formerly known as ChemSystems®, provides customers with insightful analytics, forecasts, and planning tools for the fertilizers, chemicals, polymers, oil & gas, energy and clean tech sectors. Global in scope, Nexant serves its clients from over 30 offices located throughout the Americas, Europe, the Middle East, Africa and Asia.

www.nexant.com
The Gulf Petrochemicals and Chemicals Association (GPCA) represents the downstream hydrocarbon industry in the Arabian Gulf. Established in 2006, the association voices the common interests of more than 250 member companies from the chemical and allied industries, accounting for over 95% of chemical output in the Gulf region. The industry makes up the second largest manufacturing sector in the region, producing over US$ 108 billion worth of products a year.

The association supports the region's petrochemical and chemical industry through advocacy, networking and thought leadership initiatives that help member companies to connect, to share and advance knowledge, to contribute to international dialogue, and to become prime influencers in shaping the future of the global petrochemicals industry.

Committed to providing a regional platform for stakeholders from across the industry, the GPCA manages six working committees - Plastics, Supply Chain, Fertilizers, International Trade, Research and Innovation, and Responsible Care - and organizes five world-class events each year. The association also publishes an annual report, regular newsletters and reports.

For more information, please visit www.gpca.org.ae