The current and future market for thermoplastic elastomers in automotive applications

Patrick Ellis

The global market for thermoplastic elastomers (TPE) in automotive applications is with few exceptions, growing faster than any other elastomer. It is estimated to be 1.97 million t in 2019. This is forecast to rise to 2.86 million t by 2024, with a compound average growth rate (CAGR) of 6.6 % over the period 2019 to 2024. This CAGR is slightly above the 6.2 % GAGR for the total global thermoplastic elastomers' market. The following article will have a closer look at the reasons of growth.

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1 Introduction

One of the reasons for this high growth is the need to reduce the weight of vehicles, particularly passenger vehicles. Much of this need will be achieved by the replacement of classic vulcanised elastomers. As well as weight reduction, recyclability is a major issue, which cannot be correctly addressed by vulcanised elastomers. This move is primarily based on the European Union's directive concerning end of life vehicles (ELV). There have been several directives of this nature, each dealing with a different aspect of treating vehicles which have reached the end of their useful life. This EU Directive is of particular importance, since it covers the reusability, recyclability and recoverability of vehicles at the end of their life. Only vehicles are allowed to be put on the market if they are reusable and/or recyclable to a minimum of 85 % by mass and are reusable and/or recoverable to a minimum of 95 % also by mass. All thermoplastic elastomers meet these requirements; vulcanised elastomer cannot entirely.

Another driver for the growth of TPEs is the need to improve their heat and chemical resistance. The so-called commodity TPEs, such as TPS, TPO, and TPV have a long-term heat resistance (LTHR) of maximum 100 °C. There are more expensive TPEs such as TPC and TPU, which can reach 150 °C and even as high as 170 °C. For some time now, TPEs with higher LTHR have been available, but have not had a major impact on the market. Now, the situation is changing, and more companies are offering alternative TPEs with LTHRs of up to 150 °C. The chemical resistance of these materials is also in most cases superior to that of the lower heat resistant TPEs.

There is also a demand for increased comfort and lower interior noise, which is caused by a combination of the vehicle's engine, the tyres and poor road surfaces. This is now being addressed by increased use of TPEs for the vehicle's interior. Much of this problem is being resolved by TPE foams, which can be produced with varying densities, both in the form of an open or closed cell structure. Another major driving force is the increase in the demand for electrically driven vehicles, sales of which are themselves now growing at double-digit CAGRs. The urgent need to increase these vehicles' driving range will demand serious weight reductions, which can only be accomplished with an increase in the use of plastics and elastomers in automotive construction. It is not only the passenger and light commercial vehicle production that will profit from these developments, but also that of heavy goods, buses and other forms of transportation. While slower to take off, the autonomous vehicle will require even more cables and electrical equipment than the electrically driven vehicle. Indeed, these are likely to become one and the same vehicle in the not-too-distant future.

Patrick Ellis
pellis@smithers.com
Associate Consultant
Smithers Rapra
Leatherhead, Surrey, UK

www.smithersrapra.com

All figures and tables, unless otherwise stated, have been kindly provided by the author.

2 TPEs in automotive applications

Table 1 gives a list of the more important TPE automotive interior applications. The main groups are split into three, but interior is the most important group in terms of its variety and size, compared with under-the-hood and exterior applications.

The exterior TPE applications are mainly wheel arches, body trim, rocker panel covers, constant velocity joints, steering bellows and window seals. Of this group window seals are the main challenge for TPEs, especially TPS and TPV. EPDM is the major incumbent and presents a serious challenge to TPEs. Its properties need to match EPDM, both from a property and processing point of view. The main advantages of TPEs in this application are better surface finish, easier assembly and full recyclability. Encapsulation of the rear quarter lights is already a strong TPE application; usually in the form of talc-filled TPS or TPV.

Under-the-bonnet applications for TPEs have been so far limited by their heat and chemical resistance. Radiator hose is no problem for TPV, but other applications, closer to the motor pose a problem. TPU and TPC have the necessary heat resistance, but they are more expensive than the commodity TPEs. The introduction of Hipex by Kraiburg TPE and the take-over of Zeotherm from the Zeon Corporation by RTP Company, are likely to open up more critical applications, such as those currently held by chloroprene (CR), ethylene vinyl acetate rubber (EVM) and acrylate elastomers (AEM and ACM), which are mainly for hoses. Hose applications, which demand better long term heat resistance and superior oil and resistance to other chemicals, are still beyond the reach of TPEs, but this may change in the future.

Wire and cable applications are not confined to any particular part of a vehicle, but where heat and chemical resistance, as well as abrasion resistance are required, TPU is an excellent choice.

Table 2 gives the market for thermoplastic elastomers in automotive applications for the years 2014, as well as an estimate for 2019, and a forecast for 2024.

TPS has enjoyed quite high growth in the past, for automotive applications, with a CAGR for 2014 – 2019 of 5.7 %. There are however expectations, that this might slow down somewhat to 4.6 %, for the period 2019 – 2024. This situation might change if the higher melt flow grades of TPS, based on high melt flow SEBS, take off. In addition, the introduction of vulcanisable SEBS might also add some measure of impetus to the growth of TPS. However, it is still early days to be entirely certain. TPO clearly is the major TPE in the automotive category, due to the introduction of newer metallocene catalysed low-alpha olefin copolymers. These products are often modified with higher alpha olefins and are gaining place, since they compete very well both commercially and from a property point of view, against TPOs based on compounds of PP and EPDM. They have excellent chemical resistance, as well as much better low temperature properties. Their heat resistance is adequate for the applications for which they are best suited, which is mainly exterior automo-

Tab. 1: Typical TPE interior applications in the automotive sector and suggested replacements

Position	Application	Typical incumbent	TPE replacement examples
Forward	IP-skin	PVC/ABS, PU, PVC	TPV
	IP-foam	PU, PO	TPV
	IP-substrate	ASA, ABS	Nano-filled TPO
	Rigid IP	Talc-filled TPO	Nano-filled TPO
	Control knobs	ABS, PPCP	TPS, TPO, TPV
	Air vents	ABS	Nano-filled TPO
	Console	HIPS, ABS/PVC	TPS, TPO (ST)
	Gear lever gaiter	EPDM, PVC (CF)	TPO (CF)
	Glove box	ABS, PPCP	Nano-filled TPO
	Glove box door	PPCP	TPO (ST)
	Airbag door, driver	TPC, TPS	TPV
	Airbag door, passenger	PU, PVC,	TPV
	Radio/CD cover	ABS, PPCP	TPE (ST)
	Parcel shelf	ABS, PPCP	Nano-filled TPO
	Pedal covers	EPDM, PVC (CF)	TPV
Sides	Door panels	PVC/cellulose	TPE-flax, TPE-cellulose
	Sill covers	Talc-filled TPO	Nano-filled TPO
	Window controls	PA	TPO (ST)
	Seat trim	ABS, PPCP	Nano-filled TPO
	A/B/C pillars	PPCP	TPO (ST)
Back	Rear quarter panel	PPCP	TPO (ST)
	Parcel shelf	PET/cellulose	PP/nano-filled TPO
	Safety shield	PVC(CF)	TPO (CF)
Top	Headliner	PET(NW)	TPO composite
	Sun visor	PVC/PU foam	TPV foam
Bottom	Carpets	PA	PP
	Mats	Rubber	TPO, rTPV
	Sound insulation	$BaSO_4$/SBR Foam	$BaSO_4$/TPS foam

Source: Patrick Ellis
Note: CF=Coated fabrics; NW=Nonwovens; ST=Soft touch rTPV=Recycled TPV; PPCP=PP copolymer; IP=Instrument panel

Tab. 2: Global market for TPEs by product, 2014, 2019 (E) and 2024 (F) (thousand tonnes)

TPE	2014	2019 (E)	2025 (F)
TPS	382.8	504.4	630.3
TPO	498.7	684.5	979.8
TPV	326.0	460.6	673.2
TPU	199.9	254.3	346.6
TPC	78.4	108.4	163.3
TPA	32.0	42.3	45.8
Ohers	20.0	29.8	25.8
Total	1,537.9	2,084.4	2,864.9

Source: Patrick Ellis; Note: E = Estimate; F = Forecast tive components. They already had a high CAGR of 6.5 % for the 2014 – 2019 period and will likely improve on this to reach 7.4 % for the 2019 – 2024 period. TPV is however the fastest growing TPE, since it is beginning to very seriously compete with many vulcanised elastomers. The newer breeds of TPVs are showing long-term heat resistance up to 150 °C, plus excellent chemical resistance. These TPVs are based on higher performance thermoplastics and elastomers, other than those based on PP and EPDM. The TPV CAGRs for the periods of 2014 – 2019 and 2019 – 2024, are estimated to be 7.2 % and 7.9 % respectively.

Passing onto the high-performance TPEs, TPUs are in a good position to gain market share. This is in part due to the increase in the use of wire and cable applications which are needed for electric vehicles. Their combination of heat and chemical resistance, combined with excellent abrasion resistance, sets them apart from products such as PVC. TPCs are also not far behind and are cited to replace certain vulcanised elastomers in under-the-bonnet applications, such as cable insulation and hoses. TPC can now be produced from up to 50 % bio-sourced materials, such as vegetable oils, which is an added advantage over many TPE grades. Finally TPA, which although having outstanding properties, has not made a dramatic impression on global automotive market.

3 E-mobility

The advent of the electrically powered vehicle will have both a dramatic and positive impact on the growth of TPEs. Because of this, their CAGRs are scheduled to grow from 6.3 % over the 2014 – 2019 period to 6.6 % from 2019 to 2024. The assumption that heat and chemical resistance will be less critical is entirely false. Electric motors run very hot, as do batteries while they operate, as well as during charging. There will be an increased need for cables, thus the choice of the correct cable insulation will be of extreme importance. The electric vehicle, whether fully battery operated, or in hybrid form, weighs considerably more than its internal compression engine counterpart. This can be anything from 400 to 900 kg. Therefore weight-saving is of the essence, if the current driving range of a totally electric powered vehicle is to have a range anywhere equal to that of a hybrid vehicle. Costs of electric traction are much higher than conventional vehicles and this has to be addressed as well. Noise, vibration and harshness (NVH) issues will need more attention in electric vehicles, since they will become more apparent. Here TPE foams have an important role to play. The buying public expect a good degree of silence in the vehicle's interior and this can only be obtained by proper noise insulation.

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Autonomous driving is a subject which will affect electric vehicles and here the current systems will add up to another 200 kg to the vehicle's weight another reason for using TPEs.

4 Recyclability and the circular economy

As has been already referred to, the European ELV legislation calls for up to 95 % recyclability. Vulcanised rubbers can in theory be recycled and devulcanised; but at a cost. Replacing them with TPEs would be a major step forward. The advantage of TPEs is that many types are compatible with each other; at least the first three types are. There are many potential applications suitable for such recycled blends, in and outside of automotive applications.

The use of bio-based products in the production of TPEs is extremely small. This is to some extent, a cost factor, since the bio-based replacement tends to cost more than that of those based on petrochemicals. Both TPA and TPC are available as bio-based grades and in principle, TPEs based on EPDM, can be produced from bio-EPDM. However, the cost of changing commodity TPEs to a bio-sourced content is higher than that of the higher performance TPEs. A start has been made by changing the processing oil to vegetable sources and using cellulose as a reinforcement. In theory, bio-based ethylene should reduce in price, as its production capacity increases. This could lead to the use of bio-ethylene, which is a base chemical in the production of styrene, ethylene and other olefins.

5 Conclusions

The global market for TPEs in automotive applications is with few exceptions, growing faster than any other elastomer. Their main driver is to replace vulcanised elastomers, for reasons which have already been given. In addition, they are also being used for many other applications, for which vulcanised rubber are unsuitable. This is especially the case in automotive interiors where low volatile organic compounds (VOC) need to be at microscopic levels. The challenge of e-mobility is an opportunity, not a threat, since the use of TPEs will present new opportunities. Recyclability, and the use bio-mass based content, will also help to drive TPEs' growth in automotive applications.

This article is an extract from Smithers Rapra's recently published global market study entitled **The Future of Thermoplastic Elastomers to 2024**.

For more information on this report contact:

Bill Allen, Smithers Rapra Europe/Asia,
ballen@smithers.com
Nicole Mazzocca, Smithers Rapra North/South America,
nmazzocca@smithers.com