TPEs on the road to electric vehicles and autonomous vehicles

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Automotive accounts for about 45 % of global TPE consumption. Within the automotive sector, ownership patterns are shifting toward electric vehicles (EVs), autonomous vehicles (AVs), semi-autonomous vehicles (semi-AVs), and various forms of ride sharing have entered the market. These shifts have created new functional roles for automotive TPEs. The new opportunities will result from broader performance requirements, the need to bring smart functionality (smart TPEs), more versatile fabrication process technology and shortened/shifting supply chains.

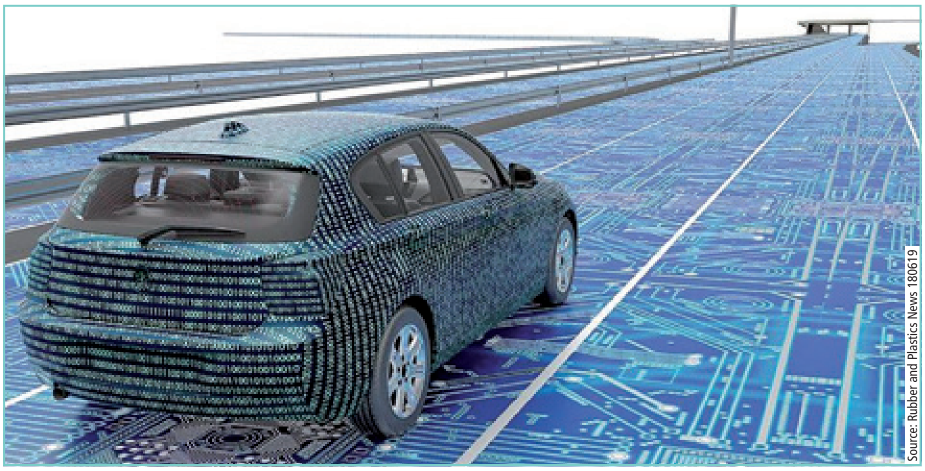

Fig. 1: TPE issues and opportunities on the evolving digital road

1 Introduction

Some of the issues to be addressed in evaluating TPE opportunities as vehicles drive the evolving digital road include how to:

- integrate with new electronics functions and capabilities,
- establish a position in a shifting supply chain,
- identify where the profits will settle,
- manage the sensor/TPE interface (sensors will be key elements in AVs),
- identify a viable path to smart TPEs,
- evaluate a role for TPEs in the plastronics vs. silicon chip competition,
- establish entry point timing for the evolution from:
  - mild → hybrids EVs
  - manual → semi-autonomous → fully autonomous **(fig. 1).**

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

2 The role of TPEs in a shifting automotive supply chain

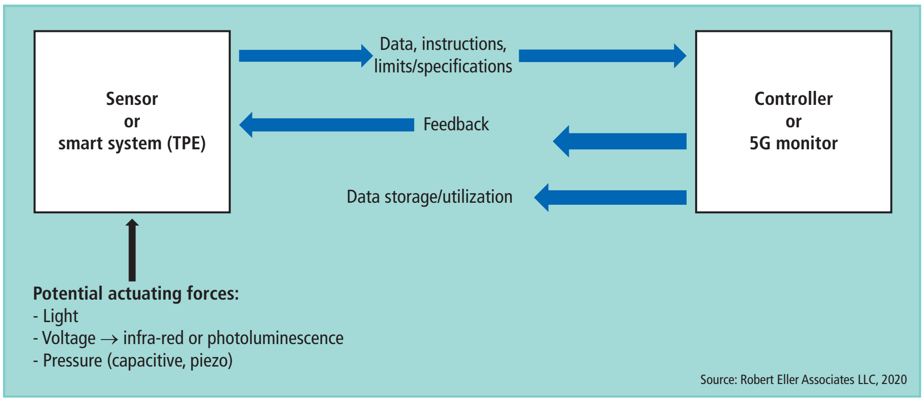
As the automobile moves toward new configurations and capabilities, the supply chain is shifting toward increased reliance on the silicon valleys of the world (USA, Europe, China, India) and the traditional auto design/manufacturing centers. An issue will be, where, between these poles will the profits settle and what will be the role of TPEs in capturing value from the improved functionality of the component parts.

3 TPEs and smart systems

TPEs will enter the EV/AV automotive segment from several directions. Prominent among these will be via sensors in the smart systems for data generation and collection. TPEs may be part of a sensor housing or as part of the sensing device that responds to several types of actuating force (light, voltage from infra-red, photoluminescence, capacitive response (as in current touch screens) or pressure generating piezoelectric charges. A schematic is shown in **figure 2.**

A concept of the AV and semi-AV vehicle and their role in interacting with the environment is represented in **figure 3** in which the moving vehicle is surrounded by electric fields from both outgoing and incoming signals interacting with 5G devices, other vehicles, the surrounding environment and the auto interior. The role of sensors is evident but some of the functions on the vehicle must adapt to the new environment thereby producing opportunities for TPEs. These adaptive functions include:

Fig. 2: Smart systems, data generation/collection concept



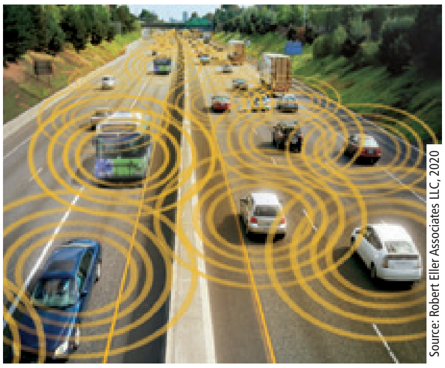
- improved acoustics (long a TPE target),
- EMI shielding,
- the projection of images onto interior surfaces,
- sensing/touch functions,
- conductivity,
- signaling/data transmission,
- piezoelectrically active TPEs via the incorporation of piezoelectric fillers,
- the use of nano-scale fillers.

Some of these functions and TPE opportunities are associated with the development of image projection onto vehicle interior surfaces which is part of the general trend toward improved automotive interior lighting and an information-rich auto interior.

4 The auto interior as TPE opportunity

The auto interior has long been a TPE battleground with competition between TPO (skins and hard surfaces), PVC, TPUs, and SEBS. The auto interior fabrication processes in particular have been the target of innovation to reduce the number of wasteful steps to fabricate the typical 2–3 layer parts. The large surface area for these auto interior parts also make them an opportunity for image projection, lighting innovations and sending/receiving functions in which TPEs can participate via some of the innovations described above.

Fig. 3: TPE opportunities and challenges in EVs/autonomous vehicles and the emergence of 5G



5 TPE role in plastronics

The incorporation of electronic components and sensors into rigid plastics and flexible TPEs offers many benefits for applications where sensing, sending or display functions are required. Film-based capacitive switches that respond to finger pressure are currently used in signal-sending applications. They offer an alternative to silicon-based devices that will grow in the applications illustrated in **figures 2** and **3.**

6 Effect of industry shifts

The auto industry has and will continue investment into AVs and EVs. Among the investment drivers is the relative ease of assembly requiring less labor and fewer components. The supply chain effects on global suppliers and the labor force are obvious but not yet fully quantified.

Sales of EVs (battery powered and hybrids) are growing rapidly in Europe. EVs are currently 10 % of new car registrations in Europe [1] but less than 4 % in the USA [2]. There is also a global shift issue. For example, Asia is ahead of the west in battery cell manufacture.

Table 1 illustrates some of the interfaces between the conventional internal combustion engine (ICE) and EVs/AVs that could affect TPEs in the auto industry.

7 Summary

As TPEs ravel the digital automotive road with EVs and AVs there will be new opportunities and some market losses.

TPE market losses will come from the shift of automotive components to new configurations or elimination of components, the ICE being the most obvious example. These market losses will come slowly and depend on market acceptance of AVs/EVs.

TPE market gain opportunities will be more rapid and will come on the road to EVs/AVs from integration with electronics functions, especially at the sensor/switch (sending and receiving) interface in addition to their use in plastronics , improved acoustics, body/glazing seals, image projection, EMI shielding, the use of active fillers and increased wiring.

8 References

[1] www.jato.com (last accessed 9 March 2020)

[2] www.lmc-auto.com (last accessed 9 March 2020)

Tab. 1: Example effects of EVs/AVs on TPEs in the automotive sector (Source: Robert Eller Associates LLC, 2020)

Component	TPEs affected	Vehicle type	Key points	Note
Constant velocity (CV) joints	COPE	EV	Some EVs have direct drive motors mounted directly on the wheel	· No half-shaft · No CV joint
Cabin heating, under-hood ductwork	TPV, SEBS, COPE	EV	Use of heat from ICE not available	Use compressors to heat air, ducting still required
Under-hood components	TPV, SEBS, COPE	EV	Under-hoods no longer are hot zones	Developing high temperature TPEs has long been driving force in TPE development
Interior skins for instrument panel, door trim, etc.	SEBS, TPO, TPU?	EV, AV	Interior surfaces become sites for image projection	Starting (at Nissan for example)
EMI shielding	All types	EV, AV	EMI shielding becomes key property	See **figure 3**
Wire/cable jacketing	All types	EV, AV	High temp not required under hood	More wiring in EVs
Switches	Flat types	EV, AV	Lower cost vs. silica-based chips	
Body/glazing seals, acoustics	SEBS, TPV	AV	Interior acoustics performance increase	Improved interior acoustics needed for voice commands, signals