Polycarbonate Compounds in Automotive Glazing Applications

Frost Study Analyzes Growth Opportunities vs Potential Hurdles

Automotive original equipment manufacturers (OEMs) are evaluating every possible opportunity to reduce vehicle weight to achieve fuel savings and reduction in carbon dioxide (CO₂) emissions. As a result, automotive glazing has emerged as one of the major automotive applications that are expected to gain significant growth opportunities in the arena of lightweight materials. Windscreens, side windows, rear windows and panoramic roofs are the key application areas for glazing in vehicles. Laminated glass and tempered glass are the most commonly used glazing materials while plastic penetration into these applications is also being witnessed. Polycarbonates (PC) and Polyvinyl Butyral (PVB) are the two main plastic compounds used in glazing applications. PVB dominates the plastics landscape for automotive glazing applications with approximately 98% share which can be attributed to its use as an interlayer in laminated glass, which holds a sizeable share in glazing applications. PC compounds, on the other hand, account for less than 2%. However, improved design freedom, superior mechanical properties along with its light-weighting capability has rendered PC as an ideal material in the glazing market. PC compounds have proven to offer up to 50% weight reduction as compared to glass.

The chart below depicts the existing and emerging applications for PC compounds in the automotive industry (fig. 1).

More Than just Light-Weighting

Apart from light-weighting, increased design freedom, part consolidation and improved functionality have gained importance among automotive OEMs while choosing materials. These aspects are becoming increasingly important as style, aesthetics and comfort have become paramount in automotive design. PC compounds have proven to offer significant advantages over conventional materials used in glazing applications. For instance, colored glazing, complex three
dimensional shapes, innovative window design such as sharp edged corners, gaps in the windows have been made possible with PC compounds as compared to laminated and tempered glass.

Wide varieties of design have been introduced where rear view mirrors, cameras and lighting modules are being integrated into the window assembly instead of attaching them to door panels. This has been possible through high level of parts integration and exceptional design freedom that PC compounds offer. These have rendered them more competitive than other glazing materials in the marketplace.

Superior thermal insulation properties of PC offer significant advantages that help optimize cabin environment, thereby reducing the overall load on air-conditioner. Another interesting area that is attracting the focus of market leaders is infrared (IR) and scratch resistance. PC compounds offer poor resistance to IR radiation and advancements in additive formulation are progressing to block or absorb radiations. Bayer MaterialScience has introduced colored PC glazing resin with IR absorbing additives for the Bugatti Grand Sport Targa Top. In addition to this, Sabic's Lexan resins, with an infrared formulation has proven to reduce heating, ventilation and air-conditioning (HVAC) load to 7.1% in winter and 6.3% in summer which in turn offers sizeable reduction of CO\textsubscript{2} emissions.

**Regulatory Scenario**

In spite of proving to be the most preferred material in other applications such as headlamps, tail lamp and other lighting applications, PC compounds have been facing significant hassles in penetrating into the glazing segment. Tempered glass is the most commonly used material for non-windshield glazing applications while stringent regulatory trends have resulted in the sole use of laminated glass for windscreen applications.

Regulation 43 in Europe governs the use of materials for windshield glazing applications while the standards specified pertains to glass and do not take plastics usage into consideration. The current situation therefore demands regulatory authorities to revise the standards and stipulate material preferences in the purview of using plastics. Test cycles and approval procedures are required to be correspondingly established. For instance, weatherability tests for glass and plastics will be significantly different from each other. Restricted penetration into windshield applications that account for a wholesome 20% of automotive glazing area curbs opportunities for PC compounds. However, compound manufacturers and component manufacturers are lobbying to permit the use of materials other than laminated glass for windscreen applications. Furthermore, polycarbonate
windshields are used in German police cars and forestry machines in order to provide best in class protection against vandals that could potentially break into the vehicle. This suggests that PC compounds, due to high impact resistance, have immense scope to penetrate into the windshield applications.

It is also important to note the fact that PC compounds have not been able to easily penetrate into the non-windshield applications (that account for close to 80% of the glazing segment), that do not even fall under the regulatory purview. Poor scratch resistance properties of PC render them unsuitable for glazing applications that have movable windows, wiper systems and frequent washes. Sabic and Bayer MaterialScience, the market leaders in PC glazing applications are working towards developing PC grades that offer superior visibility, weatherability, impact and abrasion resistance. In order to develop PC glazing with superior optical and mechanical properties, specialized coatings have to be applied on the surface. Certain challenges exist in the existing coating technologies which considerably restrain the penetration of PC compounds even in non-windshield glazing applications.

**Technological Advancement**

State-of-the-art coating technologies that offer significant resistance for more than 10 years of outdoor exposure, which is the stipulated quality standard for PC in glazing applications, are being developed in the marketplace. PC glazing systems are further required to meet and exceed regulatory requirements for driver visibility such as FMVSS 205, R43 and JIS R 3211 that have been stipulated in US, Europe and Japan respectively. This will be made possible only with a well-established coating technology.

Coatings requirements vary with individual glazing application. For instance, abrasion and weatherability requirements vary amongst the front windows, rear windows and roofing applications, which in turn demand suitable coating formulation. Polysiloxane hard coating via plasma enhance vapour deposition method has proven to effectively meet regulatory requirements as well as OEM demands. However, coating facilities are yet to be well established to support mass production applications. Cost of coating these systems eventually boost total cost of product and it is therefore compelling that manufacturers establish a cost-effective coating technique to competitively position the product in the marketplace. PC manufacturers, coating companies and automotive OEMs are working closely to establish large-scale production facilities. Certain PC compound manufacturers are also evaluating options to add in-house coating capability to achieve cost efficiency.
What's the Future for PC Compounds?

PC compounds have a promising future in the automotive glazing landscape once the issues related to coating technologies and production capabilities are addressed. Revision of existing regulatory specifications and testing methodologies for plastic based glazing systems will further facilitate adoption of PC in windshield glazing applications. Over and above this, globalization of automotive OEMs and technology transfer across regions are compelling the need for standardization in material usage. Harmonization of regulatory standards at a global level therefore remains paramount to aid the replacement of glass by PC compounds. North American standards for plastic glazing materials are the most stringent as they specify high weatherability requirements. Harmonization of standards will consequently increase the requirements on material's chemical and mechanical properties paving way for R&D activities.

Mass production and application of PC in glazing applications are expected to commence by the end of the decade as they require considerable level of advancements in terms of technology, production capabilities and revision of regulatory standards. Market participants across the value chain, including raw material suppliers, compounders, component manufacturers, automotive OEMs are striving to address the existing challenges in the marketplace. Rapid adoption of PC glazing for sun roofs, fixed side and rear window applications are expected to progress during the next five years while penetration into movable side windows and windscreen applications are projected to go mainstream during the next decade.

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