

PMMA can be found e. g. in headlamps of current vehicles (© Evonik)



Polymethyl Methacrylate (PMMA)

The World Market for PMMA Continues to Show Solid Growth

Despite the tough market environment, the global sales market for polymethyl methacrylate is showing solid business growth and is leveling out demand fluctuations. Manufacturers are increasingly focusing on non-cyclical specialties in established application fields outside the fast-moving opto-electronics industry. This decision is intended to promote solid growth in the medium term.

Global sales volumes of polymethyl methacrylate (PMMA) molding compounds and semi-finished products were 1.9 million t in 2015. Because of political unrest and growing recession, particularly in emerging economies such as Brazil, India and Russia, the world economy is only recovering slowly. Nevertheless, experts predict solid growth of 3% for the coming years. The PMMA market is thus increasingly orienting itself to the macro-economic development of the world economy.

The Asia-Pacific region, particularly the Chinese market, is the biggest consumer of PMMA, accounting for about 66% of the total market. The development of the Asian market was character-

ized by two contradictory trends: In opto-electronic application fields, the dynamism continued to decline in the past year. Direct wide-area background lighting with light-emitting diodes (LEDs) in TVs is more and more replacing PMMA edge-lit light-guide plates. However, this trend will soon bottom out, so that demand in this application will stabilize again. The demand figures for applications in the auto and construction industries, on the other hand, show an entirely opposite development. Technology and design trends and new applications as lenses or light guides in LED headlamps and for non-transparent body parts, particularly in the lower part of the vehicle, are leading to growing demand.

Above-average growth rates partly compensated for the negative development in the electronics market. In future, the market volume will also continue to be determined by the Asia-Pacific region, however with slightly reduced growth dynamism. Here, there is a change in trend away from large-volume mass applications toward more profitable specialties.

2015 was a strong year for the European and North American auto industry, and therefore for the development of PMMA demand. After Asia-Pacific, Europe (17%) and North America (15%) are the most important sales regions for PMMA molding compounds and semi-finished products. The economic development



provided positive stimuli in both regions, particularly in the automotive sector. **Figure 1** shows the main applications for PMMA molding compounds and semi-finished products in Europe in 2015. About 22% of this is attributable to automotive. Compared to 2014, sales significantly increased in comparison to other applications, not least because of the growing share of new applications in the auto segment. Currently, however, construction products (28%) still make up the biggest proportion of applications, followed by the lighting and signage segment (24%).

Manufacturers and Raw Materials Supply

For many of the raw materials required for PMMA production, such as methyl methacrylate (MMA) and MMA preproducts, e.g. acetone or methanol, the cost development has been subject to huge fluctuations in almost all regions in recent years. Over the last five years, the price level has risen by 20 to 50% in some cases.

In the fourth quarter of 2015, there were the first signs of a decline in the price level. The price drop for crude oil and the temporary balancing out of the supply/demand situation led to a noticeable recovery in the high raw materials costs. This development continued in the first quarter of 2016. However, the euphoria about the drop in raw materials costs did not last long. Toward the end of mid-2016, the first price increases were due, which are still maintaining the cost pressure on PMMA molding compounds and semi-finished products.

Since 2013, almost all the announced PMMA capacity expansions have been concluded. Mitsubishi Rayon Co. Ltd., Otake, Japan, Evonik Industries AG, Darmstadt, Germany, and Arkema SA, Colombes, France, remained market leaders in the global PMMA molding compound and semi-finished product business, with a share of nearly 45% of global capacity. However, the expansion of further capacities was significantly constrained by the highly volatile development in the MMA business. For

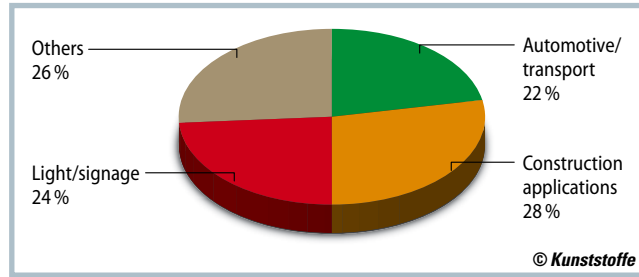


Fig. 1. The main application fields of PMMA in Europe show a uniformly distributed picture (2015) (source: Evonik)

2017, only two further investment projects are planned in the Middle East region.

Structural changes remained modest in scope and concentrated clearly on

consolidations in the semi-finished production sector. After Sumitomo Chemical Co. Ltd., Osaka, Japan, closed its production plants for PMMA molding com- »



Fig. 2. A good view for passengers: In aircraft manufacturing, PMMA is used for cabin windows, among other things (© Evonik)

pounds and semi-finished products at the Japanese site Niihama in the Ehime prefecture at the end of 2013, further closures at the semi-finished product side followed in 2015. In the same year, Arkema announced the closure of its sheet extrusion in Bernouville, France. Moreover, the European distribution business units Sun-clear for plastic and aluminum sheets were also to be sold. This was followed by the closure of the cast sheet line (Candias in Bahia, Brazil) of the Brazilian producer Unigel in early 2016, which was announced as only a temporary measure at first. Evonik also announced that the production plant in Gramatneusiedl, Austria, will be closed at the end of 2017. In early 2015, Schweiter Technologies AG, Horgen, Switzerland, took over the molding compound and semi-finished product manufacturer Polycasa from Aventas Holding GmbH & Co. KG, Illingen, Germany, thereby expanding its laminated sheet business.

Combining Design Requirements with Functionality

In recent years, it was mainly opto-electronic application fields that boosted sales of PMMA; currently, demand for a variety of specialty products is increasing. The driving forces for this are technical innovations, new products and changing design requirements. A good example is the automotive industry. From the end of the 1950s, it manufactured injection molded covers for the rear lights that were typical at the time and control buttons for dashboards from PMMA. Today,

PMMA can be found in many different vehicle parts, for example in rear lights and headlamps (**Title figure**), as pillar covers or as cover glasses and design elements in interiors.

The material persuaded automotive manufacturers through its low weight, which contributed to making vehicles lighter. This is an important argument at a time when cars are required to consume ever less fuel and emit ever less harmful emissions. On the other hand, the material is a winner because it combines design requirements with functionality. For example, non-transparent high-gloss elements of PMMA are used in many vehicles. As pillar covers or window guide covers, for example, they blend in optically with the body. The parts make the windows look bigger and give the body a high-quality appearance. The integrally colored, non-transparent automotive applications also reduce the part costs, since they are produced in one step by injection molding and do not need to be subsequently painted.

The PMMA manufacturers are also continually enhancing their portfolio for such established applications and thereby stabilizing total sales. Thus, Evonik's Performance Materials segment has developed a new special molding compound of its brand PMMA which withstands particularly high loads, for example from stone impact, and is therefore suitable for parts in the lower vehicle area. Plexiglas Hi-Gloss NTA-5 is an improved version of the special Hi-Gloss product series, which have already long been used for non-transparent body parts. It has particularly

high impact strength together with good heat deflection temperature and is also weathering resistant. As a result, the new molding compound can also be used for parts in the front or rear lower vehicle area, for example the air inlet and the radiator grille.

See and Be Seen

Besides non-transparent body parts, PMMA components are well established in vehicle lighting and are therefore used more and more in new applications in this field, too. This growing demand is driven by the sweeping success of LEDs, which only bring their advantages into effect, such as higher light yield for a lower energy consumption, in combination with a material that is tailored to them. Without a suitable cover, for example for rear lights, LEDs only radiate a strong spot light. Special headlamp optics with complicated light guide and lens systems of PMMA can illuminate different fields of view on the road with LED light, depending on the vehicle speed. Until recently, such high-tech solutions were reserved for premium vehicles. Auto manufacturers are using modern headlamps more and more for mid-class cars, too, and thereby further stimulating PMMA demand.

However, with all their advantages for headlamps, LEDs are also an acid test for the material used. Depending on the design of the optics and the LED type, temperatures of over 150 °C can arise – over long operating times. For these high thermal loads, PMMA manufacturers have developed further special molding compounds. The polymethyl methacrylimide (PMMI) Pleximid (manufacturer: Evonik) has a high heat deflection temperature and remains colorless and transparent under long-term thermal loading.

The high light yield and directed light for headlamps is a strength of LEDs together with the corresponding headlamp optics. For rear lamps, on the other hand, the current trend is that, for esthetic reasons, they should often be homogeneously lit, particularly for premium vehicles. Some German OEMs use the light-diffusing Plexiglas Satinice molding compound for this purpose. The advantage is that special scattering particles guide the light uniformly into the entire part surface – without undesirable hotspots. With »

Fig. 3. In the form of panels, PMMA is also used for household appliances and white goods (© Evonik)



these special molding compounds, designers do not need to include recesses for white or yellow covers for rear lights and direction indicators in their planning. Instead, these light functions are produced by a subtractive color mixture. The outer rear light cover is backed with covers of different colors. When illuminated, the desired color effect is produced, such as the yellow of the direction indicator; when not illuminated, on the other hand, the cover appears homogeneously red. The red shade itself also makes particular demands on the material. It is standardized and therefore requires that the material can be precisely pigmented.

Light where It Is Needed

LEDs are not only an issue in the automotive industry. Whether for road lighting, signage, designer lights, wide-area ambient lighting or artistic light installations – LEDs now shine out everywhere. With PMMA molding compounds specially tailored to these requirements, either crystal clear covers provided with structures, or light-scattering covers can be manufactured depending on requirements. They direct the light to where it is needed. For street lights, for example, the light should brighten the roads and not the space around the light source at several meters height. Suitable materials can thus contribute to reducing the energy consumption worldwide, since about 20% of global energy demand is still used for lighting. This is a huge potential – not only for the often antiquated street lighting, but also, e.g., for illuminated signage that is lit around the clock.

PMMA as a cover for LEDs, however, is not only a suitable material for efficient lighting; it also offers a wide variety of design opportunities. Besides the good processing properties of all PMMA products,

various special products are available for lighting applications.

Spectacular Successes in Everyday Applications

The many applications in lighting are an important motor for global PMMA sales, and show, at the same time, how varied the applications are in this market segment alone. The material is just as versatile in many other fields that make high demands on the material, such as architecture, electronics, medical technology and aircraft manufacturing.

In aircraft engineering, for example, materials have always had to withstand extreme temperature changes, protect against UV, resist weathering, and at the same time be as lightweight as possible. To withstand these particularly high requirements, Evonik, for example, offers stretched PMMA, which, in comparison to cast sheets produced by the standard process, offers better chemical and mechanical properties. This includes, for example, a higher optical quality, impact strength and chemical resistance, as well as good resistance to crack propagation. Familiar aircraft manufacturers, such as Airbus and Boeing, use these special products, for example, for cabin windows (Fig. 2), windshields, cockpit windows or pressurized cabins. Air traffic is growing continually, and demand for PMMA products is also increasing. To expand worldwide capacity, Evonik is therefore currently investing in a new stretching system, which, at the same time, permits larger sheets than before.

Whereas ever bigger formats are in demand for cockpit glazing, smaller PMMA parts have long been indispensable in applications of daily life. They are used, for example, in the form of robust panels for household appliances and white goods, as housing parts for coffee machines, or multifunction kitchen appliances, as high-quality cosmetic packaging, high-grade furniture edges, lenses of reading glasses and much more (Fig. 3).

PMMA will open up further new application fields. At the same time, the manufacturers are further developing their special products to improve existing application fields. ■

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