Polymethyl Methacrylate (PMMA)

Advances in LED Technology Bring Continuing Solid Market Growth

The trend to plastics specialties that are independent of the economic cycle is continuing and boosting demand in the PMMA market. Strong growth stimuli are coming from the automotive industry, the construction and lighting industries, and household appliance manufacture. Upheavals on the raw material side are countering this positive trend.

The forecasted market growth of 3% for PMMA molding compounds and semi-finished products has proven correct. In 2016, nearly 2 million t were sold worldwide, mainly to the construction, automotive, and electronics industry. Over the last few years, negative impacts have been experienced mostly in optoelectronics applications. In backlighting units for TV flat screens, the change in technology from edge lighting to direct lighting led to a considerable fall in demand for light-conducting sheets made from PMMA. The negative trend in this specific application seems to have bottomed out and is stagnating on the current low level for the first time.

Economic development in Asia, in particular, has a crucial influence on the PMMA molding compounds and semi-finished product market. Just under two-thirds of the global demand came from the Asia-Pacific region, with China far out in front, followed by South Korea and Japan. After a temporary downturn in 2015, China (the largest net PMMA importer) once again recorded an increase in import volumes in 2016.

More than half of the Chinese demand is covered by imports, although there is a trend towards expansion of local PMMA production capacities in order to better meet rising demand in future and become more independent from foreign exports.

In past years, the Asian market has been characterized by a demand for standard products. But with the increasing globalization of automotive and lighting OEMs and their suppliers, the demand for specialties in this region has increased rapidly and in the medium term offers attractive growth opportunities for applications outside the commoditized optoelectronics industry.

One-third of the demand comes from regions outside Asia. In the second-strongest region, Europe, approximately 17% of the global demand for PMMA molding compounds and semi-finished products was sold, followed by North America (14%). The main customer industries in the various regions differ. In Europe and North America, there is no significant production of optoelectronic components, while the construction, lighting, and automotive industries are of primary impor-
The leading global manufacturers of PMMA molding compounds and semifinished products continued to be Mitsubishi Chemical Co., Ltd, Tokyo, Japan (formerly Mitsubishi Rayon Co., Ltd), Evonik Industries AG, Essen, Germany, and Arkema SA, Colombes, France, who between them accounted for just under 45% of total production capacity. In 2016, there were no major structural changes in the PMMA producer landscape. New production plants have not so far commenced operation. At the start of 2017, the Japanese MMA and PMMA producer Mitsubishi Rayon Co., Ltd (Osaka, Japan) and two further subsidiaries of Mitsubishi Chemical Holdings Corporation were formally consolidated into the new Mitsubishi Chemical Corporation.

**Availability of MMA Was Sometimes Severely Limited**

Although the demand side of the PMMA market environment presented a positive and robust picture during the past year, there were far more turbulent trends on the raw material side, which had a massive influence on PMMA market development. The availability of methyl methacrylate (MMA), the raw material required for PMMA production, and its precursors, was severely limited by a number of planned plant shutdowns and unplanned production outages coinciding with a generally good business trend. In the automotive sector, the industry that is currently among those providing the strongest growth stimuli for PMMA demand, components made from PMMA are increasingly moving center-stage and is the driving force for profitable growth.

**Manufacturers and Raw Material Supply**

The number of applications in which PMMA can be found is increasing steadily. Whereas a few years ago it was primarily optoelectronics applications that strongly drove PMMA demand, although ultimately causing it to drop sharply again, market growth today is based on the increasing diversity of application opportunities for PMMA.

The main reason for this is that polymethyl methacrylate has so many different properties, making it a sought-after material in a wide range of industries. PMMA is particularly in demand, for example, in applications where weathering resistance, color fastness, high brilliance and transparency, as well as hardness and scratch resistance are key requirements. But besides these functional properties, manufacturers are increasingly discovering PMMA as a design material.

PMMA can be colored in virtually any shade, permits a high degree of shaping freedom, and offers a variety of surface finishes. So, for example, with Plexiglas molding compounds, the PMMA branded product from Evonik, it is possible to produce high-gloss, deep black pillar covers that can visually enlarge the look of vehicle windows, thanks to their glass-like appearance. This is only one of the applications for PMMA in the automotive sector, the industry that is currently among those providing the strongest growth stimuli for PMMA demand. Components made from this material are lightweight but robust, can be economically produced by injection molding, and enable car designers to create new design shapes.

PMMA has also helped shape the design of mobile devices over the past few years. The material has made it possible for displays to be ever flatter. In order for users to see anything at all on an LCD display, the screen must be lit. In edge-lit LED displays, light conductors made from PMMA, such as Plexiglas, frequently fulfil this function. Light conductors, in turn, have become ever thinner and therefore lighter in recent years. For example, in 2009 a light-conducting sheet in a laptop display was 3 mm thick. Three years later,
Here, energy-saving light-emitting diodes have long been established. But because the light sources themselves only give off pinpoint light, LEDs rely on a good light diffuser that directs light to where it is needed.

A light is more than just a light. It assumes various functions. In supermarkets, it sets the scene for effective presentation of products on the shelves, in work stations it ensures a comfortable brightness, and as ambient lighting it creates a special atmosphere. PMMA producers such as Evonik have a continually growing number of specialty products in their range that are tailored to the different requirements. Depending on the end application, these can be used to produce crystal-clear, textured or light-diffusing covers. In all cases, the high transparency and good transmission properties of PMMA in combination with LEDs make it a suitable material for energy-efficient lighting.

The material offers enormous energy-saving potential. In supermarkets, for example, the light has to present the products and create a pleasant ambience throughout the opening time of the store. It is not surprising then that lighting is one of the greatest energy consumers and retailers are increasingly switching to energy-efficient LED lighting systems. For example, the Spar Austria retail chain has installed the Tecton LED continuous-row lighting system from Zumtobel Lighting GmbH, Dornbirn, Austria, a supplier of building interior lighting solutions (Fig. 2).

This reduces the energy consumption of all the artificial lighting in an average...
supermarket by at least 40% as compared with the use of fluorescent tubes, while also improving light quality.

**Reducing Component Costs**

Higher light output, even lighting, and lower energy consumption have made PMMA a sought-after material for round-the-clock illuminated advertising for very many years. For LED light boxes and lettering, PMMA manufacturers such as Evonik developed specialties with suitable properties back in the early 2000s. A good example is Plexiglas LED Block (Fig. 3). This white, highly diffusing block material permits homogeneously illuminated letters to be obtained. These can be cut out relatively easily from the block material as individual letters that must be assembled from a back wall, a surround, and a cover – which makes the illuminated lettering efficient to produce. In this way, flatter designs are also possible, since the LEDs are inserted in a groove.

**Surface Finishing**

Besides its optical properties, PMMA is also currently in demand for the finishing of other plastics. Areas of use include household appliance manufacture and the construction industry. In these applications, PMMA imparts its good properties to the underlying materials. On housings, thanks to its high transparency, Plexiglas provides a seamless, very high-gloss surface with depth effect. This not only looks stylish and attractive but is also pleasant to touch. At the same time, the PMMA layer protects underlying materials in constant use, since this engineering plastic has the highest surface hardness of all thermoplastics and very high chemical resistance. So the PMMA layer makes surfaces more durable to mechanical stresses or cleaning agents – important properties for high-quality kitchen appliances such as the Thermomix food processor from Vorwerk & Co. KG, Wuppertal, Germany (Fig. 4). After all, these appliances not only have to be practical but also keep their stylish look for as long as possible.

To ensure that an attractive appearance is retained long-term, PMMA surface finishing also protects the underlying materials from UV radiation. This resistance to solar radiation is also used by manufacturers of window profiles. They coextrude PMMA directly with polyvinyl chloride (PVC) into the finished window profile, without using an additional adhesion promoter or apply the material subsequently as a protective film. The PMMA not only increases UV resistance but also fastness to weathering. So window profiles with a protective layer of PMMA retain their original color and pore-free smooth surface for a long time, even if, following the current architectural trend, the windows are dark in color and therefore could normally be expected to fade more quickly.

This report describes just some examples of how diverse the possible applications for PMMA have now become. All in all, technical developments are going hand in hand with the growing variety of PMMA products.

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Fig. 3. The white, highly diffusing block material Plexiglas LED Block makes it possible to produce evenly illuminated lettering (© Evonik)

Fig. 4. For the curved white housing of the Thermomix food processor, the manufacturer chose a high-gloss surface finish with Plexiglas molding compounds (© Vorwerk)