



A new hydrolysis-resistant PBT variant used in an ESP control system from Bosch withstands very strict temperature/humidity cycling tests (figures, except for Fig. 6: BASF)

Polybutylene Terephthalate (PBT)

Strong in Electronics and Automotive Construction. Polybutylene terephthalate is one of the very versatile polymers. This injection molding-friendly, semi-crystalline polymer is used, for example, to produce electronics housings for auto manufacture and communications electronics, among other fields of application. Global consumption of PBT as an engineering plastic was around 830,000 t in 2012. So the downturn of the crisis years has been overcome and forecasts have regained their previous optimism.

Polybutylene terephthalate (PBT), a saturated polyester obtained from butanediol and terephthalic acid or dimethyl terephthalate, is used in the plastics industry as the basis for high-performance compounds or blends, e.g. with ASA, PET or PC. The large PBT suppliers are generally backward inte-

grated to the polymer. PBT materials are characterized by high dimensional stability, high stiffness, and good heat resistance. By incorporating fillers, reinforcing materials, and additives during compounding, material properties can be tailored to requirements. In this way, materials suitable for many different applications can be produced. They are processed mainly by injection molding but unreinforced PBT is also used in special extrusion and fiber spinning processes.

Market Development, Producers, and Capacities

Like many other engineering plastics, polybutylene terephthalate also suffered from the crisis of 2008/2009. But by 2011/2012, the pre-crisis sales level was regained. Demand is expected to grow by about 5 % per annum for the next few years. So PBT seems to have overcome the hard times.

One of the reasons for this is the resurgent growth of the automotive sector, which, at

least from a global perspective, is steadily recovering. Although automobile OEMs in Europe are still having to grapple with sales problems on account of the euro crisis, the industry as a whole, particularly in Asian countries, is enjoying increasing sales. The growth in the quantity of plastic components being produced is also benefiting PBT.

Global consumption of PBT by region is shown in (Fig. 1). Compared with 2009, North and South America have fallen back slightly in

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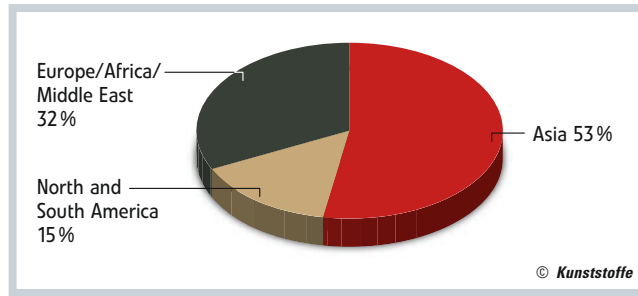


Fig. 1. Global PBT consumption by region in 2012 (total 830,000 t)

favor of Europe, Africa, and the Middle East, while demand in Asia has remained constant. The importance of the Asian market will increase in the medium term. Further strengthening of this region is expected by 2025. It is assumed that then around 60 % of the global PBT market will be in Asia. Overall, some 1,650,000 t PBT (including blends) will be consumed in 2025 (Fig. 2).

Among the large suppliers, there have been no significant shifts over the past few years (Table 1); capacity expansion is currently taking place mainly in Asia. In 2013, Sipchem Chemicals Company (LLC), Riyadh, Saudi Arabia, announced that it plans to build the first PBT plant in the Middle East.

Applications

The described growth of the PBT market is currently taking place in the large established segments (Fig. 3). In the auto electronics sector, the increasingly widespread incorporation of safety, efficiency, and comfort functions in cars is opening up many additional application opportunities for PBT. In addition to the electronic stability programs (ESP) already widely used, there are new applications such as reversing cameras, electronically controlled air flaps behind the radiator grill (Fig. 4), automatic parking aids or trunk opening via a motion sensor. In all cases, additional connectors, sensors, and/or control units are required, which can be very successful-

electrical performance and so ratchets up continuous service temperature requirements.

In other automotive applications, the quest for more efficient production is creating new impetus. Headlight bezels made from PBT, and then post-metalized, require materials with good process-

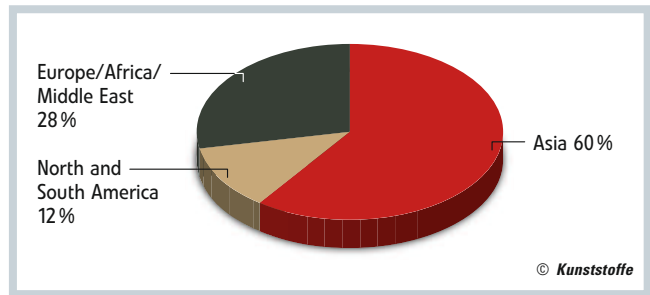


Fig. 2. Expected global PBT consumption in 2025 (total 1,650,000 t)

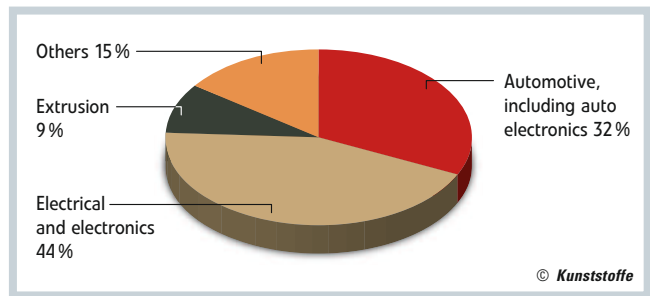


Fig. 3. Main fields of application for PBT in 2012

ly produced from PBT materials. Along with the multiplication of electrical functionalities, there is also a trend towards miniaturization of these components, which slightly dampens growth. But where miniaturization leads to live circuits being positioned in closer proximity, new opportunities may arise for PBT materials because of their excellent electrical insulation properties – even in the presence of moisture and at high temperatures. The gradual emergence of battery-powered vehicles will open up new high-voltage applications (e.g. charging plugs). Some of these applications may require the use of flame-retardant products. One effect of miniaturization is to make electronic assemblies more compact. This gives rise to higher temperatures for the same

ing stability and low fogging (Fig. 5). In addition, it should be possible to injection mold bezels for as long as possible without having to clean the highly polished mold surfaces. To satisfy the extremely high surface quality requirements for the bezels, special materials are needed with very low tendency to mold plate-out. Continually optimized special grades help processors achieve successful results here.

Apart from automobiles, PBT can also be used in many other applications – sometimes in combination with other plastics. Examples range from shower heads and artificial grass to insulin pens and fiber-optic cables. In the latter case, particularly, where PBT tubing is extruded as protective jacketing around the glass fiber strands, faster processing

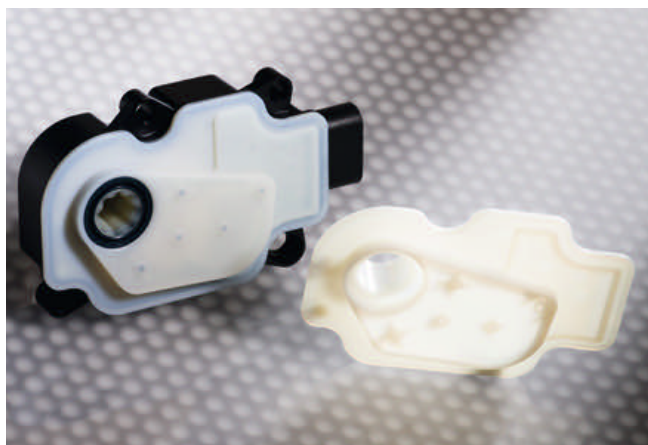


Fig. 4. Thanks to its high transparency to infrared light, glass fiber-reinforced Ultradur LUX B4300 G4 can be very rapidly and economically laser welded. The material is already being used in serial production of an air flap control module by Precision Motors Deutsche Minebea

speeds, haul-off speeds of 400mm/min and more, and the demand for very thin cables are stretching established materials to their performance limits. When the extrusion process makes such high demands, then important end product criteria, such as low ovality and high strength, can only be satisfactorily achieved with specially developed materials.

In the power electronics sector, flame-retardant PBT materials with high tracking resistance can be used. For example, the direct current produced by photovoltaic modules is transformed into high-voltage alternating current in solar inverters by so-called insulated-gate bipolar transistors. PBT is very suitable for the housings of such systems thanks to its exceptionally good electrical properties.

Opportunities are also opening up for PBT in the injection molded packaging sector. Although PBT is not one of the cheapest polymers, it possesses a very good combination of oxygen, moisture, and aroma barrier properties and, as a low-viscosity, fast-crystallizing product with short cycle times, can also be processed into very thin-walled parts. So PBT offers a versatility that can otherwise only be achieved by combinations of different plastics in multi-step production processes. From the perspective of system costs, therefore, PBT has definite potential as a packaging plastic.

New Products

To address the trends towards higher temperatures and more efficient production described above, new PBT →

Producer	Trade name	Headquarters
BASF	Ultradur	Germany
Bluestar	Bluestar PBT	China
Chang Chun	Chang Chun PBT	Taiwan
DuPont	Crastin	USA
Lanxess	Pocan	Germany
Mitsubishi	Novadur	Japan
Sabic	Valox	Saudi Arabia
Ticona	Celanex	Germany
Toray	Toraycon	Japan
WinTech	Duranex	Japan

Table 1. The most important PBT producers



Fig. 5. High-gloss metalized headlight bezels are an important PBT application. A newly developed PBT is characterized by extremely low out-gassing in extended operation at 160 °C, whereas standard PBT can cause fogging of the headlight lens under such operating conditions

materials have been developed that meet the increased requirements.

Hydrolysis-stabilized PBT grades have been used successfully for a number of years in auto electrics and electronics, especially for components under the hood, which are exposed to the interaction of moisture and high temperatures. Some established materials, e.g. Ultradur B4330 G3 HR (HR = Hydrolysis Resistant), already have sufficiently high stability for current applications with challenging heat stresses. This material hardly changes its properties at all, even in thin-walled components when exposed, for example, to the sharp temperature/humidity cycling conditions of USCAR 2 standard class 5 (175 °C peak temperature) (Title figure). So PBT automotive connectors can achieve the highest temperature class. The wider use of HR materials is also leading to finer differentiation in terms of combination with additional properties. Newly available materials, for example, include products that are hydrolysis-resistant and flame-retardant and others that are hydrolysis-resistant and laser-weldable (as a laser-transparent jointing partner).

Highly laser-transparent Ultradur LUX, which was launched at K 2010 and can be rapidly and reliably laser-welded, is starting to become established on the market (Fig. 4). In addition, new PBT variants especially for use in contact with drinking water have recently come onto the market (Fig. 6).

On the subject of resource conservation and the sustainable use of materials, another promising development is on the horizon. Following the use of recycled PET as a blend component with PBT or its conversion to PBT by chemical modification (transesterification), biobased monomers have now arrived, as shown in a recent production trial conducted by Lanxess AG, Cologne, Germany, in which biobased 1,4-butanediol was used for PBT synthesis. Since biobased monomers do not differ chemically from their counterparts based on fossil raw materials, their downstream products – in this case the polymer PBT and compounds produced from it – also have the same properties. That is the special advantage of these so-called drop-in solutions for renewable resources. Another product that has been around for longer on

the market is a polyester (polytrimethylene terephthalate, PTT, trade name: Sorona) from DuPont, Wilmington, USA, in which the diol monomer (1,3-propanediol) is likewise biobased. This polyester is specially aimed at fiber applications. A key requirement for the use of biobased monomers is that they can be obtained efficiently from suitable renewable resources – a task that is accomplished with varying degrees of difficulty, depending on the target monomer.

Another promising new development is a product from BASF for the extrusion of tubes for fiber-optic cable

is the fact that the new product has even less tendency to hydrolysis. These advantages are achieved through additives that modify the solidification behavior of PBT by producing a fine crystalline morphology that starts to form just below the melting point.

Outlook

The growth of the PBT market is taking place mainly in established fields of application. This growth is being accompanied and supported by evolutionary development of PBT materials. This is leading to optimized products with special adaptations and prop-



Fig. 6. Products that come into contact with drinking water must have considerably lower migration values than specified under current food contact regulations. A newly developed PBT complies with a whole range of European qualification requirements for use in contact with cold and hot drinking water (figure: Grohe)

jacketing. Ultradur B6550 LNX significantly outperforms previous products in practically all important properties. Very high haul-off speeds, thin walls, and small diameters can be achieved in the extrusion process. The tubes obtained have increased strength – notably up to twice the transverse compressive strength – and yet still possess the elongation at break value that processors have become accustomed to with predecessor materials. Another bonus

erties tailored to the developing requirements of the particular market segment. The example from the fiber-optic cable sector shows that significant improvements in processing and properties are still possible. In any case, the PBT market and its applications will continue to remain exciting and innovative in the future and offer good prospects for growth. ■

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