

Styrene Copolymers (ABS, ASA, SAN)

Andreas Chrisochou and Daniel
Dufour, Leverkusen/Germany

Over the years, styrene copolymers have grown into a large product family. It now consists not only of the straight copolymer of styrene with acrylonitrile (SAN), but also of graft polymers derived from it, elastomer-modified with butadiene or acrylic ester rubbers or ethylene/propylene/diene terpolymers (ABS, ASA, AES). The family also includes the blends of other thermoplastics such as polycarbonate (PC) or polyamide (PA) with styrene copolymers (e.g. PC+ABS, PC+ASA and PA+ABS).

Even though – particularly in the case of ABS – the sales volumes could almost be described as “commodity-like”, styrene copolymers should be regarded as engi-

neering plastics because their wide range of ‘adjustable’ properties and variety of processing methods enable the manufacture of high-grade components that have proved themselves time and again in particularly demanding technical applications.

■ Market Situation

Contrary to previous growth forecasts [1, 2], the year 2001 brought an unexpected decrease in the market as a result of the downturn in the global economy. World-wide consumption of ABS, SAN and ASA fell from just under 4.9 million t in 2000 to around 4.7 million t in 2001 (Fig. 1). This tendency was even more marked in Europe and North America. The exception were styrene copolymer blends, which managed to more or less maintain their

high previous year's level in all the regions of the world apart from North America (Fig. 2).

Recent developments indicate, however, that the decline has already bottomed out and that there is an upward tendency in all regions. Forecasts predict that the total consumption of ABS, SAN and ASA world-wide will grow up to 2004 by approx. 4 % annually world-wide and around 2.5 % in Europe. The outlook for the blends is even more promising: In Europe and the world as a whole, annual consumption is expected to increase by a good 7 % during the same period.

Asia plays a leading role in terms of global growth. Particularly China, which consumes around a third of world-wide ABS production and is thus by far the biggest consumer country, still has unfilled demand. For this reason, many manufactur-

Translated from *Kunststoffe* 92 (2002) 10,
pp. 94–98

ers are currently planning to build new production facilities there or to expand existing capacities.

As has already been observed in the last few years, the supplier structure on the global market is slimming down all the time. The most recent example is the joint venture UMG ABS signed in the spring of 2002 between Ube Cycon (former joint venture of Ube Industries and GE Plastics) and Mitsubishi Rayon. As a result, it moves up to become the second largest manufacturer of styrene copolymers in Japan. Table 1 shows the ABS/ASA/SAN capacities in the world's regions for 2001/2002, together with the major producers.

Because of overcapacities, Asian manufacturers in particular sometimes offer their product at very low prices on the European and American markets. The local suppliers are countering this import pressure with customised supply and service packages that include, for example, part design and development right the way through to project management.

Production

Two processes have become established for producing ABS: the emulsion process and the continuous bulk polymerisation process. The emulsion technology continues to dominate the scene, accounting for more than 90 % of production capacities installed world-wide. SAN as the end product is produced almost exclusively by the continuous bulk process, especially where product grades with outstanding optical properties (e.g. with regard to transparency) are involved. Other processes like the emulsion and suspension processes are nowadays only used in SAN production for intermediates for manufacturing ABS.

Over the years, the main processes have undergone constant further development with regard to their environmental compatibility, waste prevention and in particular product quality. Europe is leading the way because, in addition to the stricter legislation, customer industries such as the automotive segment also stimulate constant process improvements because they specify, for example, products with a drastically reduced emission of volatile components. Such demands relate not only to the processing process but above all to the emission characteristics of the product in final use.

Main Applications

The areas of application in which styrene copolymers and their blends are used have barely changed in the last few years. The biggest customers are still the automotive industry, the electrical/electronics industry and information technology (IT). Together, they accounted in 2001 for more than two thirds of the European consumption of 9 651 000 t, as shown in Fig. 3.

Automotive: As far as parts for car interiors are concerned, ABS and its blends have been able in recent times to win market share from polypropylene because of their technical and economic advantages in all vehicle classes. Their main strengths are a more favourable cost-to-benefit ratio, superior coating characteristics, higher heat resistance and a high level of toughness also at low temperatures (safety from splintering in the event of an accident).

Region	Capacity [1000 t]	Share [%]	Main producers
Europe	1050	16	Bayer, GE Plastics, BASF, Dow, ENI
North America	950	15	GE Plastics, Bayer, Dow
Latin America	200	3	BASF, Bayer, GE Plastics
Japan	800	12	Techno Polymer, UMG ABS, Nippon A+L, Asahi, Toray
Rest of Asia	3500	54	Chi Mei, LG Chem., Formosa, Cheil, Toray
World total	6500	100	

Table 1. ABS/ASA/SAN capacities and major manufacturers in the regions (status 2001/2002)

Apart from that, the so-called "one-product" concept is gaining in popularity. Here, the aim is to employ only one single grade of each of the plastics used in the interior. The concept offers the system supplier and the car manufacturer wide-ranging advantages, extending from construction and design to logistics, and it also simplifies material recycling. In the interior of the new Audi A4 (title picture), for example, only a single ABS grade is used, from which, among other things, the door liner, centre console and the housing for the glove compartment are made. Another big advantage of this material is that it complies with Audi's drastically reduced emission level, and is thus already in line with the stiffer emission thresholds generally being observed in the automotive industry.

High-strength (PC+ABS) blends that can withstand high dynamic loads at low temperatures are gradually becoming the material of choice for safety components

exposed to chest, head or leg impact. Fracture resistance and freedom from splintering also make these (PC+ABS) variants the logical solution for components located in areas where airbags inflate, for such articles as airbag covers. In addition, the new (PC+ABS) blends comply with the more stringent requirements on the heat deformation behaviour of vehicle interior parts.

ABS also has something to offer when it comes to the optical aspect of the car interior. Many parts with a decorative surface, particularly consoles, are being increasingly produced with ABS film by in-mould decoration (IMD). There are two prime reasons for this: Firstly, special surface effects such as the "black piano finish" look or an aluminium design with a matt effect can be achieved quickly and economically even with low volumes, and secondly, the films have excellent adhesion

to the (PC+ABS) blends onto which they are frequently moulded.

A new (PA+ABS) blend suitable for on-line coating is considered to have excellent market prospects for plastic car body parts with a Class A finish. Its heat resistance under practical conditions is significantly higher than that of (PPO+PA) blends, which are the only other thermoplastics on the market suitable for the online coating of car body parts. Other strengths apart from its lower coefficient of thermal expansion include above all its higher stiffness and very good flow characteristics.

Electrical/electronic and IT applications: In the electrical/electronic segment, there is a certain trend towards styrene copolymer blends that are halogen-free and thus ecologically compatible. The art is to give these grades good electrical and mechanical properties at the same time. A successful example of such a tight-rope walk are the halogen-free (PC+ABS)

blends developed specifically for extrusion and blow moulding that comply with the fire protection standards in the electrical installation and construction segment and in public transport. They can be extruded into all kinds of profiles such as cable conduits, bus bars or guide rails for optical waveguides. In such cases, they are an alternative to traditionally used plastics such as PVC.

In information technology, too, (PC+ABS) blends are playing an ever more important role – depending on the application, also as a flame-retardant grade – because they can be processed without problem by the thin-wall technique. They enable the section thickness of housing components for articles such as laptops, mobile phones and personal digital assistants (PDAs) to be reduced even further. Another advantage is that the thin-wall technology can frequently be combined with the IMD process to gain extremely economical manufacture, with the added possibility of changing the decorative surface quickly and easily. The net result: lightweight, ready decorated parts produced in extremely short cycle times. This is demonstrated by the example of the cordless Siemens telephone in Fig. 4. Compared with the previous model, the cycle time for manufacturing the housing has been cut by 60 % and the wall thickness reduced by a third.

Outdoor applications: ASA and AES and their blends with PC are increasingly

being used as ageing-resistant, weather-stable materials for outdoor applications. The range of applications extends from exterior parts in the automotive and transport industries to cladding and profiles in the construction sector and leisure and sports equipment, e.g. boats.

Advances made in the coextrusion process have recently made it possible to produce complex multi-layer systems that consist, for example, of a standard ABS as the carrier and a weather-resistant styrene copolymer as the facing layer. These systems can replace conventional composite systems based on metal or glass fibre reinforced thermosets such as sheet moulding compounds (SMC). The advantages are obvious: The styrene copolymer systems have low emissions in production and processing (occupational safety), are easier to recycle, are lighter in weight and also have a better surface quality – and it all comes without additional, cost-intensive coating processes. This makes them particularly suitable, for example, for the production of large-area structural parts for camper vehicles.

Currently being launched on the market is a new light-stable and ageing-resistant (PC-AES) blend that also has high impact strength at low temperatures. It has even better weather stability than most styrene copolymer systems so far encountered in outdoor applications. Another strength is its versatility in processing, opening up a correspondingly wide range of market

prospects. In the vehicle and camping sector, for example, it allows the production of liners and interior parts (e.g. in convertibles) by extrusion, thermoforming or injection moulding. It displays the same flexibility in processing in the building and installation industry, where the new blend is ideal for the production of window and doorframes, outside wall elements and switches and plugs.

■ The Authors of this Article

Dr. Andreas Chrisochou, born in 1967, is Product Manager in Strategic Marketing Styrenics in the Plastics Business Group of Bayer AG.

Daniel Dufour, born in 1944, is head of the same department and responsible for the global marketing strategy for styrenics in the Bayer Group.
Contact: frank.rothbarth.fr@bayer-ag.de

Fig. 1. Market development of ABS/ASA/SAN in Europe and in the world in the period from 1998 to 2004

Verbrauch = Consumption; Welt = World; Prognose = Prognosis

Fig. 2. Market development of styrene copolymer blends in Europe and in the world in the period from 1998 to 2004

Verbrauch = Consumption; Welt = World; Prognose = Prognosis

Fig. 3. Consumption breakdown of ABS/ASA/SAN and their blends in Europe by area of application (status 2001)

Automobilbau = Automotive; Elektrotechnik/Elektronik = Electrical/electronics; Informationstechnologie = Information technology; Spiel, Sport, Freizeit = Fun, sport, leisure; Bauwesen = Construction; Sonstige = Others

Fig. 4. The (PC+ABS) housing of this cordless telephone is made by the thin-wall technique – combined with in-mould decoration – in extremely short cycle times