Styrene-based polymers offer diversity for processors

The third most important polymers in terms of volume, following polyolefins and vinyl, are styrene-based resins.

Styrenics cover a full range of materials from commodity grades including general-purpose and high-impact polystyrene (GPPS, HIPS), styrene-acrylonitrile (SAN), and acrylonitrile-butadiene-styrene (ABS) to specialties such as acrylonitrile-styrene-acrylate (ASA), blends such as ABS/nylon (ABS/PA), so-called transparent ABS, which is methylmethacrylate-butadiene-styrene (MABS), and styrene-butadiene-styrene (SBS).

Top: ABS housing for this Black & Decker garden power tool provides good impact resistance for hard tasks outdoors.
Left: Bottle chiller "Cooly 2" from German processor Adoma (Wangen), injection molded of SAN, keeps drinks at an optimum temperature.

PS, ABS, SAN

GPPS is stiff and transparent but lacks impact resistance for some applications. This is overcome in HIPS, in which butadiene rubber is incorporated. The rubber phase in HIPS produces a milky appearance caused by the rubber's light-scattering effect. The chemical resistance of GPPS is greatly improved by copolymerization with acrylonitrile monomer to produce the transparent polymer SAN. In ABS, the addition of butadiene rubber particles increases impact strength, but at the same time, the transparency is lost.

These four styrenics are well-established products and are now large-tonnage commodities where competitive advantage is attained through economies of scale, acquisitions, mergers, and investment in worldscale production facilities.

In recent years ABS growth has been slightly above GDP, whereas PS growth has been on par with GDP. Margins in 2004 were unsatisfactory and at press time they appeared likely to remain the same in 2005, at least for ABS. For PS there was a slight improvement in margins during the first few months, but it remains doubtful whether this is sustainable. Since many changes have occurred

in the polystyrene market in the last 12 months, BASF, for example, is currently working on a new pricing concept. It also sold its North American PS production this year, including the 385,000 tonnes/yr GPPS and HIPS plant in Joliet, IL, to INEOS Americas.

One route materials suppliers have taken to cut costs is to selectively reduce their portfolios. For example, in Europe, BASF phased out its business of precolored and compounded ABS during 2003, and followed suit with PS last year. The net effect is a streamlining of its product portfolio in both ABS and polystyrene by more than 95 %. [Editor's note: The company has also cut back its grade range in other regions, but not as drastically.]

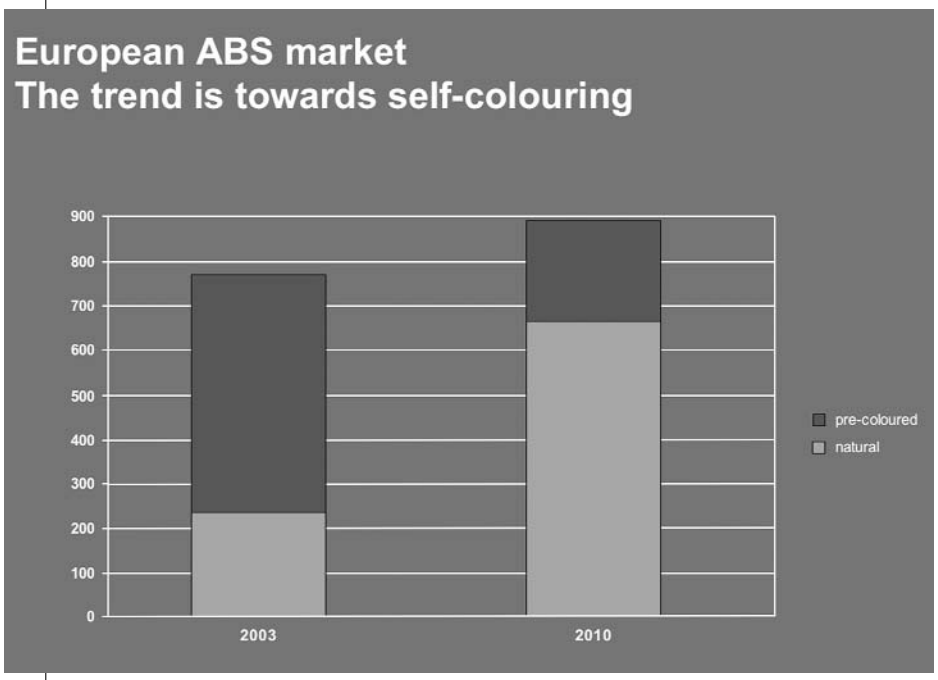
What remains are uncolored grades produced in high volumes. ABS is supplied from the company's three world-scale facilities in Mexico, Korean, and Belgium. This last plant, in Antwerp, makes just three standard product lines, covering virtually all sectors of the market.

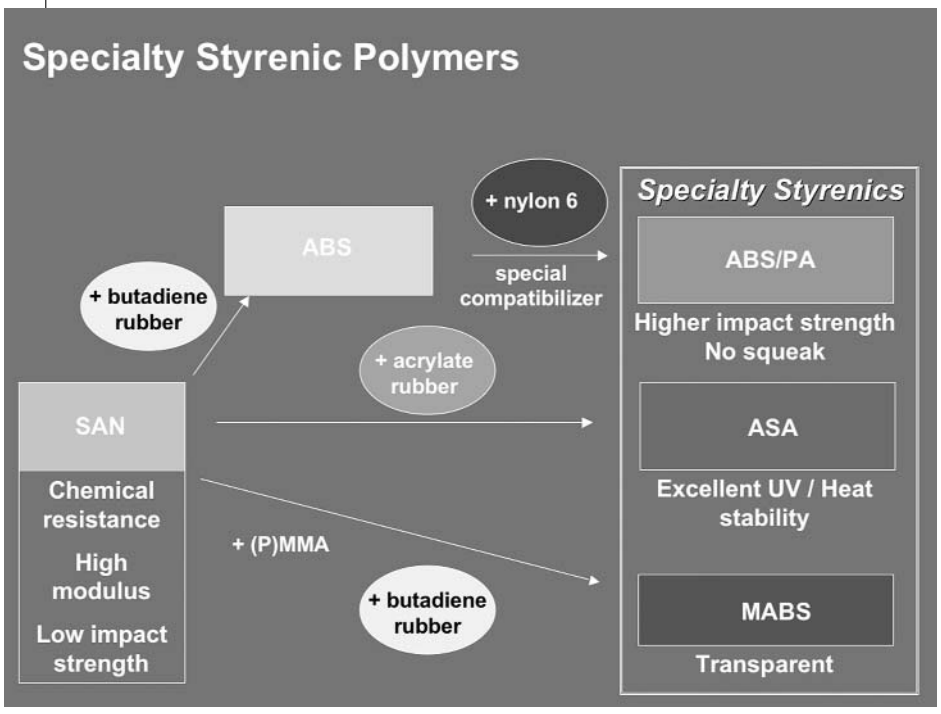
Taking the place of the precolored materials is a self-coloring service package, ColorFlexx, in which processors do the coloring themselves using color masterbatch. ColorFlexx (developed with masterbatch suppliers Albis, Clariant, Schulman, and Ultrapolymers) provides quality solutions at lower costs and shorter delivery times than precolored products. [Editor's note: Some other ABS suppliers provide similar self-coloring services.] This business model is transferable, and BASF is looking for opportunities outside Europe.

Specialty styrenic polymers have enjoyed double-digit growth in recent years and this is expected to continue. This has been achieved by offering a comprehensive package including joint development projects, system solutions, and effective logistics and services, such as the capability to supply relatively small quantities and custom colors. These are smaller tonnage, more costly materials that provide value to the processor, for example, by increasing a product's quality or by reducing system costs through specialty plastics that allow aesthetic parts to be made without painting.

MABS

MABS can be thought of as a transparent ABS as it has similar mechanical properties, chemical resistance, and processability to ABS. Clever tuning of the refractive indices of the rubber and matrix gives a material that combines the advantages of

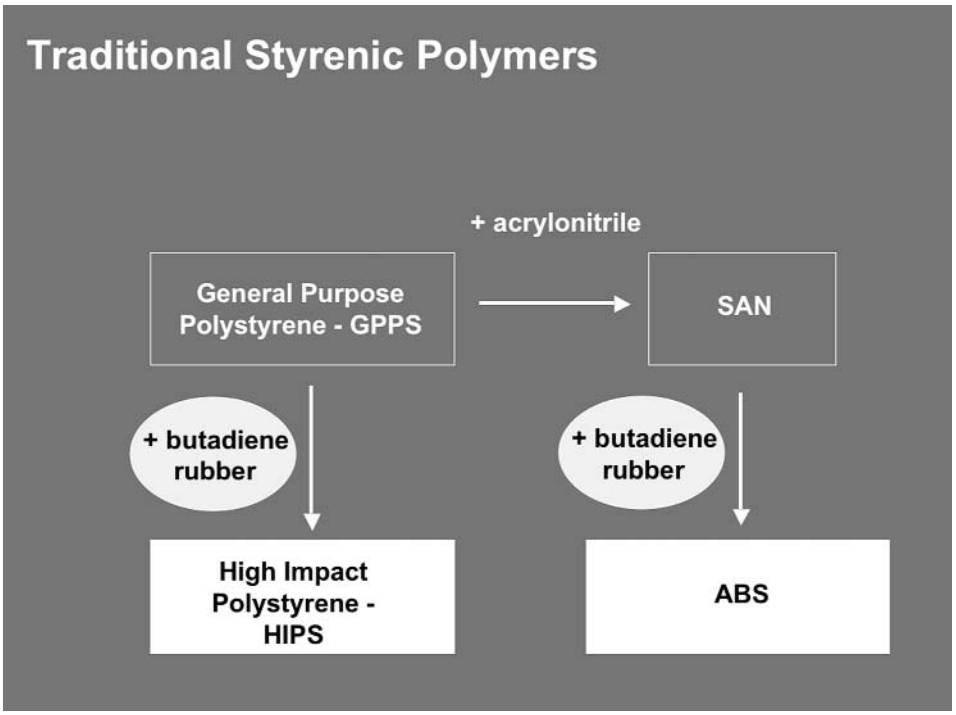




Top: European ABS market: Self-coloring by the processor is on the rise.
Bottom: Specialty styrene resins offer a wide range of uses for various applications as seen in this BASF graphic.

ABS with the transparency of GPPS, SAN, polymethylmethacrylate (PMMA) and polycarbonate (PC).

MABS is more readily colorable than PC while providing good resistance to environmental stress cracking. It is an amorphous plastic meaning that the shrinkage of MABS is similar to ABS and PC, so it can be processed in molds made for those polymers.



Addition of rubber improves polystyrene's impact resistance for many electronic and electrical as well as appliance applications.

ASA

Butadiene rubber is added to ABS, which helps impact strength but can yellow noticeably over time, especially under the influence of heat and/or UV light. The rubber can degrade and leave the material brittle. In applications where excellent outdoor resistance is needed, or where the customer wants to focus on high-quality products, ASA is a natural choice. It can survive extreme conditions without any change in gloss, color, or mechanical properties. For this reason it is widely used for exterior automotive parts such as grills and mirror housings. ASA is also well suited to the building and construction industry. Chemical resistance is better than for ABS. Where extra impact resistance is needed commercial ASA/PC blends are available.

ABS/PC blends

These are widely used due to the good processability given by the ABS and the good impact strength offered by the PC. Typical applications include mobile telephone housings and other electronics applications. While the mechanical properties are good, polycarbonate is susceptible to environmental stress cracking, so ABS/PC may not be suitable for applications where contact with cleaning agents and solvents is expected.

ABS/PA blends

Nylon blended with ABS is substantially similar to ABS/PC and competes in many applications. They offer high flow and display substantially higher environmental stress-cracking resistance compared to ABS/PC. For good mechanical properties, ABS/PA needs to be made using a special compatibilizer that creates a co-continuous network of the two polymer phases. This gives good impact strength as well as "no-squeak" behavior and excellent mold filling so that matte mold surface textures are faithfully reproduced. This latter property has led to widespread use of ABS/PA for interior automotive parts where the part is matte with no need for an expensive painting step.

SBS

Styrene and butadiene can be combined to create block copolymers SBS or SBC. These are tough materials with modifiable properties depending on the ratio of monomers and the morphology of the phases. The high toughness, transparency, and good miscibility with standard polystyrene means that these materials are favored by the packaging industry where SBS variants are extruded or coextruded to produce films or thermoformed sheets. SBS that contains a higher level of butadiene can be used as an additive with other styrenic resins to improve impact strength, as well as in other polymers, including polyolefins, where even low levels of SBS can give substantial improvements in toughness and elongation to break.

The styrenic polymer family is well established and one of the most important among thermoplastics. The stability of styrenic plastics and their recycleability are positive attributes that ensure that styrenic polymers will continue to play an important role.

The big-volume products GPPS, HIPS, SAN, and ABS are sold using a commodity approach of high efficiency and large tonnages combined with careful rationalization of the product range. In contrast, the specialty styrenics provide enhanced performance tuned to the specific needs of different applications. The success of these products is driven by innovation.

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