

## POLYMERS BEYOND THE YEAR 2000

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**Abstract** At the turn of the century, the global polymer industry is undergoing the most rapid and dramatic changes in its history. Emerging markets, particularly in Asia, and their polymer consumption are catching up with other parts of the world, creating new business opportunities. Economy of scale, combined with optimized logistic concepts, is becoming a key economic success factor, thus forcing smaller suppliers out of business and creating a major hurdle for newcomers and the introduction of new products. Globalization of polymer customers and cost pressure lead to a consolidation of suppliers and products. Today standard thermoplastics have a dominant position in the market and they will retain this position in future. Engineering thermoplastics are facing growing competition due to the increased efficiency of standard polymers. This leads to a displacement process where standard polymers substitute engineering thermoplastics. Simultaneously engineering polymers are pushing into new markets or applications or displacing materials like glass, wood or metal. The recent history and future trends have a strong impact on R&D activity in the polymer industry. Competition on a global scale and increasing cost pressure are turning innovation into an essential precondition of commercial success, thus determining the objectives of industrial polymer research and development.

**Key words** Polymer research, Thermoplastics, Globalization, World-scale capacity

At the turn of the century, the global polymer industry is undergoing the most rapid and dramatic changes in its history. Plastics producers have responded to the changed environmental conditions — emerging markets in Asia, globalization of polymer customers, cost pressure, new production technologies — with a series of measures including process optimization, construction of world-scale plants, portfolio divestitures, joint ventures, takeovers of competitors and globalization of their own operations.

During the past two decades we have seen a significant increase of the global polymer consumption. Since 1980 world-wide production has been growing faster than the countries' gross domestic product. The growth of plastic consumption is expected to continue mid-term and will be particularly strong in Asia, whereas growth rates in Western Europe, America and Japan will be only moderate.

The overall good market prospects are, however, counterbalanced by a rapid expansion of production capacity. As a consequence, the prevailing downward trend of profit margins for polymeric materials, which started in the eighties, still continues.

More recently, the strong expansion in new world-scale plants has brought about the vicious circle of over capacity and even more increasing pressure on margins, thus exacerbating the position of less competitive manufacturers.

While in the eighties the maximum capacity of a polyethylene plant was 100,000 tpa, the new installations' output is about 450,000 tpa, the next generation being planned today will have capacities of up to 600,000 tpa.

Overall, cost control through economy of scale as well as superior technology has become a very important, if not the most important economical success factor. As a consequence, the number of corporate mergers, portfolio divestitures and joint ventures increases.

Consolidation, however, is not only a phenomenon of the polymer industry. The globalization has triggered

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the concentration process in other markets as well, e.g. the automotive, the electrical and electronics business. These major polymer consumers have started to build their own production sites in the world's growth regions. The polymer industry as a major supplier of raw materials has to follow and, consequently, has established production facilities wherever customers operate. This proximity to customers opens up new opportunities by allowing faster response to customers needs.

Other driving forces for globalization are the prospects of growing into new markets, lower distribution, raw material and specific R&D costs. Since, however, the construction of new production sites is very capital and personnel intensive, only financially strong companies can afford to invest in capacities world-wide.

A limited number of globally available core products is another prerequisite for efficient cost control. Today standard thermoplastics have a dominant position in the market and they will retain this position in future. Engineering thermoplastics are facing growing competition as a result of the increased efficiency of standard polymers. This leads to a replacement process in which standard polymers substitute engineering thermoplastics. Simultaneously engineering polymers are pushing into new markets or applications or replacing materials like glass, wood or metal.

The recent history and the future economical trends have a strong impact on R&D activity in the polymer industry. Competition on a global scale and increasing cost pressure are making product and even more process innovation and optimization an essential precondition of commercial success. In this context project and knowledge management are becoming important tools to make a significant contribution to the fast and successful completion of development work.

A focal point concerns the optimization of existing plants and processes. Computer modeling is gaining importance in these areas. Whole production plants together with their material flow can be computed and simulated, thus accelerating the speed of engineering and erection of new facilities.

New technologies have a high potential for cost-saving. e.g. the gas-phase technology for polyethylene leads to a marked decrease in manufacturing costs.

Low sales prices both for standard and engineering plastics, on the other hand, provide a high barrier to the introduction of new polymers since the market launch of a new plastic material is estimated to cost on average approximately US\$ 100 million.

New polymers, which can be produced in existing facilities, are an exception. PTT (polytrimethylene-terephthalate), the missing link between PET and PBT, is a perfect example. The polymer was launched most recently into the global market. Production is economically attractive since it was possible to reduce the production costs of the raw material propane-1,3-diol.

Low raw material prices for ethylene, propylene and carbon monoxide were also the principal reason for the development of polyalkylene-ketones.

For the foreseeable future polymers manufactured with the aid of catalysts or through controlled polymerization remain an important topic in materials research. The prospect of being able to produce block or homopolymers with a defined molecular architecture and chain length is fascinating. "New" polymers from "old" monomers can be envisioned.

The ongoing "cannibalism" between different plastic materials made it necessary to optimize existing products, which are now making inroads into new markets and applications. In the case of exterior automotive body panels, for example, improved processing techniques and products have resulted in a new application: Paintless Film Molding, a new surface coating method which renders the coating process obsolete.

Besides "market pull" and "technology push" external factors, demands of society, such as sustainable development or legal requirements are the other important initiating factors for research projects. A contribution on the part of the chemical industry to sustainable development are biodegradable plastics, innovative products with alternative means of disposal. Biodegradable plastics, which are attacked by microorganism and completely broken down under the influence of environmental factors as found in the soil or in compost, can be built up from purely synthetic modular blocks. Newly developed products, such as Ecoflex<sup>®</sup>, an aromatic aliphatic copolyester, are currently in the market launch phase.