

INTRODUCTION

Over the past half century, the plastics industry has been one of the fastest growing industries, both in the U.S. and globally. Its products are consumed in applications throughout the economy and continue to grow in such important markets as packaging, building and construction, electrical and electronics, transportation, health care, consumer goods, toys, and consumer durable goods such as appliances, computers and related equipment and communication equipment. The trend toward lighter-weight and higher performing motor vehicles with improved energy efficiency has also created significant opportunities for plastic products.

In the United States, the plastics industry currently contributes 2.3% to the GDP and employs 0.7% of the total labor force, and 6.0% of all manufacturing workers, and is one of the few manufacturing industries that is showing employment gains. The United States, a world leader in plastics technology, currently exports about 12% of its production.

This industry continues to be one of the fastest growing segments of the \$506 billion (2004) chemical industry. The impetus behind this high rate of growth is the versatility of plastics. As plastics continue to displace other materials in a wide variety of applications and end uses, they are recognized as offering superior performance, usually at lower cost. Plastics can be formulated with specific physical, electrical and chemical properties tailored to meet the requirements of an endless series of applications in practically every industry. Continued innovations in product development provide new opportunities that spur growth for plastics.

Plastics are also important in resource utilization. Crude oil and natural gas are the main feedstocks in the raw material chain that leads to the manufacture of basic plastics materials. Plastics manufacturing, on a value-added basis, is the most efficient use of these resources.



ECONOMICS

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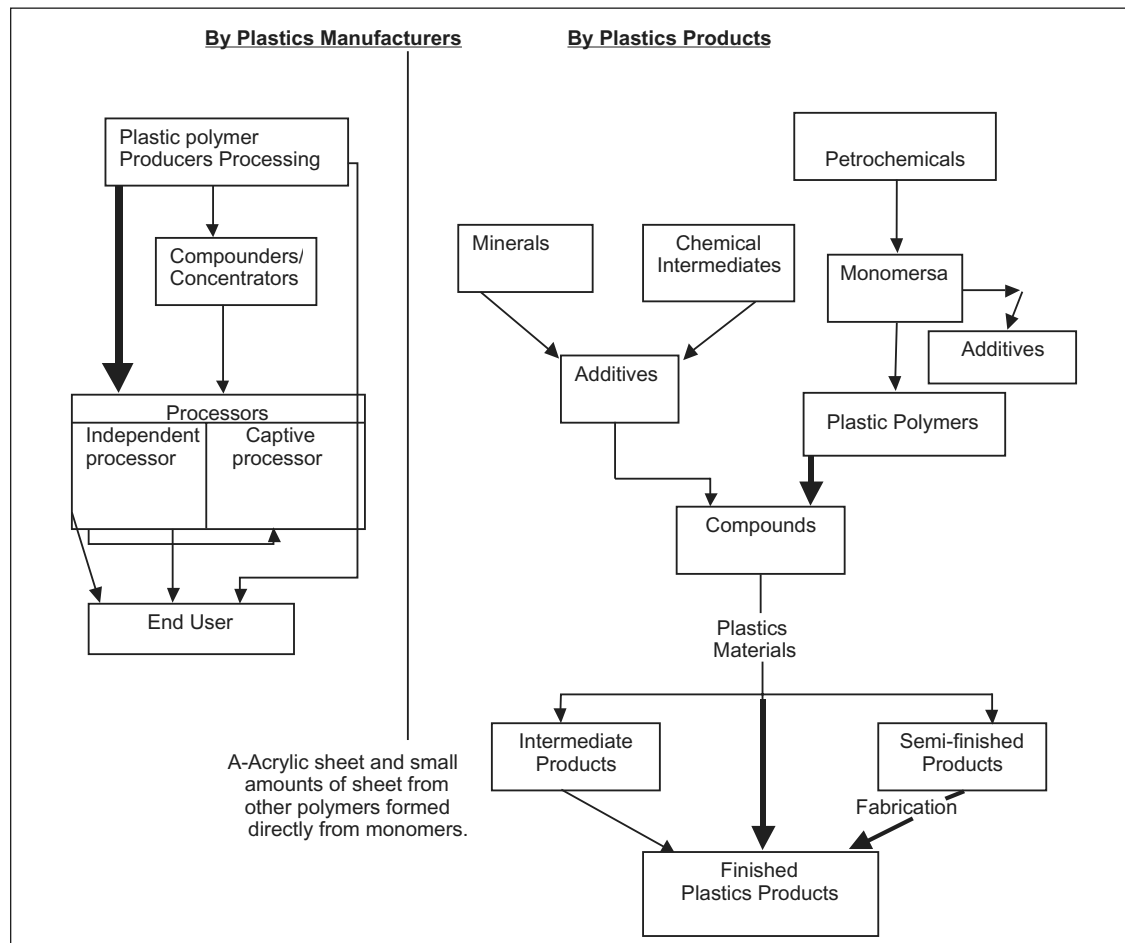
Plastics materials and resins (NAICS 325211, formerly SIC 2821), the basic materials of this industry, fall within the classification of the larger and older chemical industry NAICS 325, formerly SIC 28). Their value of shipments represents 10.6% of the shipments of the chemical industry.

The industry also includes the next manufacturing step—compounding or formulating—followed by processes that convert plastics materials into usable products or forms. Processed plastics products are classified as miscellaneous plastics products (NAICS code 326) and are covered under NAICS codes 32611 through NAICS 32619). Prior to 1997, miscellaneous plastic

products were part of SIC code 308. Figure 1-1 shows the structure of the plastics industry by manufacturers and by the classification of plastics products.

Plastic materials are produced by about 525 basic material suppliers operating nearly 550 plants. Processing is done by (1) facilities of manufacturers of other end products, (2) independent processors of proprietary and custom products, and (3), basic materials suppliers and suppliers of plastic processing equipment. There are some 12,000 independent processing plants in the U.S. and over 10,000 captive plants. Facilities that are solely or mainly involved in plastics processing are reported

FIGURE I-1 Structure of the Plastics Industry



to the government as plastics industry establishments regardless of the overall corporate NAICS classifications.

The processing sector molds, extrudes, casts or otherwise processes, fabricates, and finishes plastics into articles and goods of definite shapes designed either for final consumption or for use as a part or component of some other products. This sector is composed of a large number of molders and extruders and a smaller number of laminators and reinforced plastics manufacturers.

Molders and extruders use powders, granules, pellets and flakes; laminators use liquid polymers and sheets of paper or fabric; and reinforced plastics manufacturers use liquid polymers with such reinforcing materials as glass fiber, cloth and paper or prereinforced molding compounds to form shapes. Fabricators utilize such semifinished forms as sheets, film, rods, tubes, blocks, special shapes preforms, profiles, and laminations.

Plastics are defined as materials comprised of synthetic polymers of high-molecular weight that, when shaped by flow based on pressure and heat, become solid in their finished state. Processed plastics are either discreet products or parts of components of other non plastic products. The formation of plastic products includes basic plastics materials, such intermediate products as expandable beads and specialty compounds and concentrates, semifinished products, including rods, tubes, slabs, film and sheet, and such finished products as bottles, containers, pipe and conduit, and housewares.

Examples of plastic use in other industries include converted flexible packaging, automotive trim, boats, toys, sporting goods, luggage, furniture, wire and cable, and other products. Excluded from the scope of the plastics industry are the value added by fabricators and finishers and the total value of additives, processing equipment, and molds. However, additives are discussed in "Section 2" and equipment in "Section 4."

The manufacture of plastic products is basically a three-step process. First, the basic resin or polymer is produced from various chemical compounds. In the second step, the resin is mixed and compounded with other materials to produce an intermediate compound ready for processing. Finally, plastic compounds are processed into products or forms by the use of heat and/or pressure.

Consumption of plastics in the United States is the sum of sales plus imports less exports. Usually sales and use data describe domestic consumption by material and by end use. Such data indicate that plastic materials and resins volume grew at a rate of 5.2% a year from 1980 to 1990, 5.1% annually between 1990 and 2000 but slowed considerably to 3.3% a year between 2000 and 2004, still somewhat higher than that for all chemicals, or manufacturing. Thermoplastic materials accounted for 84% of total production in 2004. A detailed tabulation of sales by major polymer is shown in Section 3 in Table 3-1.

Table 1-1 shows plastic shipments, both resins and plastic products for 1972, 1980-2003 and estimates for 2004. Between 1980 and 2004 the value of total shipments increased an average of 6.4% annually. By sector, basic plastics have increased at 5.4% a year and processed plastics at 6.9% annually. In recent years, dollar value of plastics materials and resins increased slowly due primarily to the recession that started in late 2000 and the events of September 2001 that caused a slowdown of economic growth. Processed and finished plastic products account for 74% of the total, and plastic resins and materials the balance.

In this *Guide*, the term "structural resins" excludes products in the form of solutions, pastes, powders, or emulsions that are consumed in such uses as paper and textile coatings, foundry resins, and adhesives. Paints or finishes and inks are not considered as plastic applications, and

TABLE I-1 Shipments of the Plastics Industry 1972-2004-a

Year	<i>Plastic Materials and Resins</i>		<i>Miscellaneous Plastic Products</i>	<i>Total Shipments</i>
	<i>Billion lb</i>	<i>\$ Million</i>	<i>\$ Million</i>	<i>\$ Million</i>
1972	25.5	\$4,486	\$10,696	\$15,182
1980	36.9	14,908	30,582	45,490
1981	38.8	16,676	34,122	50,798
1982	36.6	15,769	37,013	52,782
1983	42.2	18,936	40,398	59,334
1984	45.2	20,776	47,793	68,569
1985	47.2	20,262	49,761	70,023
1986	48.5	21,484	52,243	73,727
1987	51.2	26,246	61,594	87,840
1988	55.2	32,110	67,244	99,353
1989	58.2	34,741	66,551	101,292
1990	61.3	31,325	72,759	104,084
1991	60.6	29,565	72,417	101,982
1992	65.7	33,299	81,261	114,560
1993	68.8	33,589	87,973	121,562
1994	75.9	37,710	97,479	135,189
1995	78.7	37,695	103,210	140,905
1996	84.3	40,500	110,000	150,500
1997	88.8	45,226	124,445	169,671
1998	91.7	45,028	132,488	177,512
1999	97.5	46,528	140,258	186,786
2000	101.1	52,215	145,761	197,976
2001	101.1	46,718	140,606	185,981
2002	107.5	46,718	140,846	187,564
2003	106.9	49,743	142,768	192,511
2004-e	115.1	53,500	150,900	204,400

a- Includes nonstructural uses, and plastics production by all industries.

b- Includes polyurethanes.

e- Estimate.

Sources: SPI; Bureau of Census, *Synthetic Organic Chemicals (until 1994)*; and estimates by Impact Marketing Consultants.

thus polymers consumed in these products are also excluded. Such nonstructural uses account for about 16% of domestic consumption. Plastics are also used in other industries not covered in this Guide. Plastics consumed in the hose and belt industry (NAICS 3262C) for such applications as flat belts, non-flat transmission belts, garden hoses and miscellaneous products, and in the footwear industry (NAICS 3162A) along with rubber and leather, are also excluded. A detailed discussion of rubber materials is presented in our sister publication, the *Rauch Guide to the US Rubber Industry*.

Figure 1-2 shows the interrelationship between materials, processes, products and end uses within the plastics industry. The figure pinpoints the structural sector within which the dominance of extrusion and injection molding is also shown.

The plastics industry utilizes three basic technologies: 1) synthesis, which involves the formation of the basic polymer; 2) formulation, which includes mixing or compounding polymers and additives to obtain a material in the desired intermediate form that will have the proper processing and end use characteristics; and 3) processing, the art of combining plastic materials with equipment under specific conditions of heat, pressure and time to form a desired shape or form.

Many developments have been the backbone of the industry's high growth rate since 1960, but most important has been the continued investment in research and development. Much of the early efforts expanded the knowledge of polymerization that began in the 1930's. This investment created not only new products to sustain growth but also innovative low-cost basic manufacturing processes and faster, larger and more efficient processing equipment.

Together new products and processes contributed substantially to the industry's long period of dynamic growth, which

continues up to the present time. The development of new classes of catalysts has continued to yield advances in polymerization technology leading to new products with improved properties. Such processes require high capital investment for a large part of the industry's output. The rate of investment, as a percent of shipments, is higher than that for all manufacturing.

The dynamics of high growth, new products, and modified processes occur within a uniquely competitive environment and, in fact, are in large part brought about by it. Unlike most other capital-intensive industries, a few companies do not account for the major part of the industry's production. Aside from the competition of a large number of producers serving the same market, the plastics industry also faces competition among different products for the same application. In addition, it also has competition among different raw materials and manufacturing processes, all with varying cost structures, for the production of the same products.

One effect of intense competition is continuous pressure on prices. Falling prices improved the competitive position of plastic products compared to nonplastic materials and thus opened large new markets to the industry. In the past, deteriorating prices were supported by gains in productivity through process improvements and economies of scale.

In the past 30 years, important changes have occurred in the industry. It has weathered two or three energy crises, skyrocketing feedstock costs on numerous occasions, and survived overcapacity and chronic price competition any number of times. The industry has also gone through several periods of restructuring and consolidation with many companies leaving the industry as their business strategies change. Toward the middle of the present decade the plastic materials and resins segment of the industry is operating at high rates of capacity utilization, although