# Industry & Trade Summary

## Synthetic Rubber

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**Washington, DC 20436**

**UNITED STATES INTERNATIONAL TRADE COMMISSION**

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# PREFACE

In 1991 the United States International Trade Commission initiated its current *Industry and Trade Summary* series of informational reports on the thousands of products imported into and exported from the United States. Each summary addresses a different commodity/industry area and contains information on product uses, U.S. and foreign producers, and customs treatment. Also included is an analysis of the basic factors affecting trends in consumption, production, and trade of the commodity, as well as those bearing on the competitiveness of U.S. industries in domestic and foreign markets.[1]

This report on synthetic rubber covers the period 1991-95. Listed below are the individual summary reports published to date on the energy, chemicals, and textiles sectors.

| *USITC publication number* | *Publication date* | *Title* |
|---|---|---|
| **Energy and chemicals:** | | |
| 2458 | November 1991 | Soaps, Detergents, and Surface-Active Agents |
| 2509 | May 1992 | Inorganic Acids |
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| 2578 | November 1992 | Crude Petroleum |
| 2588 | December 1992 | Major Primary Olefins |
| 2590 | February 1993 | Polyethylene Resins in Primary Forms |
| 2598 | March 1993 | Perfumes, Cosmetics, and Toiletries |
| 2736 | February 1994 | Antibiotics |
| 2739 | February 1994 | Pneumatic Tires and Tubes |
| 2741 | February 1994 | Natural Rubber |
| 2743 | February 1994 | Saturated Polyester Resins in Primary Forms |
| 2747 | March 1994 | Fatty Chemicals |
| 2750 | March 1994 | Pesticide Products and Formulations |
| 2823 | October 1994 | Primary Aromatics |
| 2826 | November 1994 | Polypropylene Resins in Primary Forms |
| 2845 | March 1995 | Polyvinyl Chloride Resins in Primary Forms |

[1] The information and analysis provided in this report are for the purpose of this report only. Nothing in this report should be construed to indicate how the Commission would find in an investigation conducted under statutory authority covering the same or similar subject matter.

# PREFACE—Continued

| *USITC publication number* | *Publication date* | *Title* |
|---|---|---|
| **Energy and chemicals—*continued:*** | | |
| 2846 | December 1994 | Medicinal Chemicals, except Antibiotics |
| 2866 | March 1995 | Hose, Belting, and Plastic Pipe |
| 2943 | December 1995 | Uranium and Nuclear Fuel |
| 2945 | January 1996 | Coal, Coke, and Related Chemical Products |
| 3014 | February 1997 | Synthetic Rubber |
| **Textiles and apparel:** | | |
| 2543 | August 1992 | Nonwoven Fabrics |
| 2580 | December 1992 | Gloves |
| 2642 | June 1993 | Yarn |
| 2695 | November 1993 | Carpets and Rugs |
| 2702 | November 1993 | Fur Goods |
| 2703 | November 1993 | Coated Fabrics |
| 2735 | February 1994 | Knit Fabric |
| 2841 | December 1994 | Cordage |
| 2853 | January 1995 | Apparel |

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# ABSTRACT

This report addresses trade and industry conditions for synthetic rubber during 1991-95. Synthetic rubber is an important raw material used mainly in the production of tires. It is also used in the manufacture of a myriad of other products such as hoses and belting, footwear, wire and cable coverings, and adhesives.

- U.S. producers of synthetic rubber appear to be competitive in foreign markets, primarily due to their ability to offer a wide range of well-priced products. The United States became a large producer of synthetic rubber during World War II, when supplies of natural rubber from Southeast Asian countries were disrupted. U.S. industry currently benefits from both the strength of the domestic market, which has the world's highest level of consumption, and the openness of foreign trade. Major U.S. trading partners in synthetic rubber generally apply equivalent duty-free treatment for synthetic rubber in primary forms and minimal tariffs for compounded rubber and rubber in "other forms."

- During 1992-95, the United States was the world's leading producer of synthetic rubber. In 1995, U.S. production reached an estimated 2.4 million metric tons, representing about 26 percent of the estimated 9.1 million tons produced worldwide. Most of the world's synthetic rubber capacity is located in Western Europe, the United States, Japan, and Russia.

- The Soviet Union was the largest producer of synthetic rubber in 1991, accounting for 23 percent of world production. Most Soviet production capacity was located in what is now the Russian Federation. By 1995, Russia's production level had declined to roughly 10 percent of world production. As Russian production declined, Japan, contributing approximately 16 percent of world production, became the second largest synthetic rubber producer behind the United States. Overall, global production did not change significantly during this period.

- U.S. exports and imports of synthetic rubber both increased during 1991-95. The largest export market for the United States during this period was Canada, whose imports of U.S. synthetic rubber products totaled $348 million in 1995.

- There are nine major types of synthetic rubbers produced in the world for use in a variety of end products. The most widely produced synthetic rubber, styrene-butadiene rubber (SBR), accounts for slightly over 50 percent of world production. SBR is commercially available in three main forms--latex, solid, and carboxylated. The primary use of SBR is in the production of tires. Butadiene rubber production ranks second to SBR in both the United States and in global markets. U.S. production of butadiene rubber currently approximates 22 percent of total domestic synthetic rubber production, up from about 19 percent in 1991. This product is used mainly in tire and belting applications.

- Synthetic rubber is produced by four main types of producers--petroleum and natural gas companies, chemical companies, tire companies, and government entities. With the exception of government entities, synthetic rubber producers are large and global in scope--12 firms account for more than 60 percent of world synthetic rubber production.

# INTRODUCTION

This report covers synthetic rubber for the 5-year period, 1991 through 1995. The United States was the world's largest producer and consumer of synthetic rubber in 1995, producing approximately 2,410,000 metric tons (mt) valued at approximately $4.5 billion. Synthetic rubber is an important raw material used in the production of tires, industrial rubber goods such as hoses and belting, footwear, wire and cable coverings, adhesives, and sporting goods. Of these, the downstream tire industry, estimated at $12 billion in size, is the largest end user of synthetic rubber. Synthetic rubbers are contained in standard industry classification (SIC) grouping 2822.

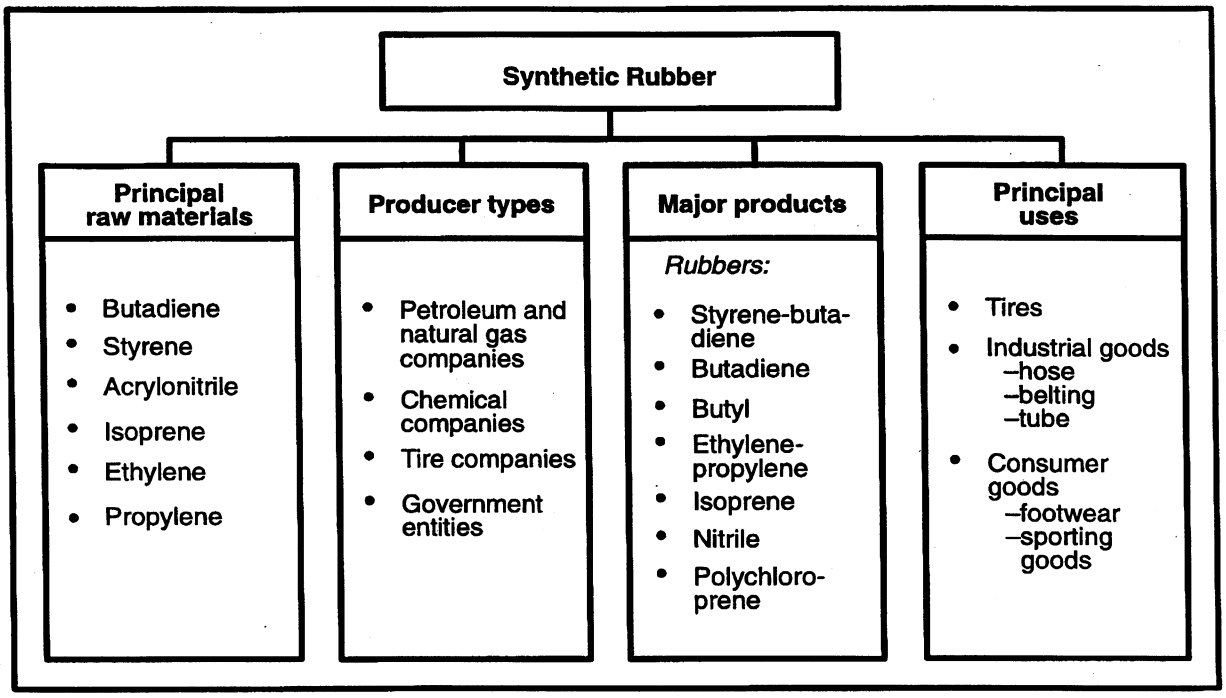
This summary of industry and trade information on synthetic rubber is organized into four main sections: U.S. industry profile, U.S. market, U.S. trade, and foreign industry profile. The U.S. industry profile section describes the product, the various types of synthetic rubber, and product applications. The U.S. market section provides information on U.S. consumption and production of synthetic rubber. The segment on U.S. trade includes data on the trade balance, U.S. imports and exports levels, principal suppliers, and U.S. and foreign trade measures. The foreign industry profile section provides information on the major world synthetic rubber producers and markets.

Foreign trade of synthetic rubber is an important part of the world rubber industry. Most synthetic rubber is produced in the United States, Japan, Russia, and the countries of Western Europe. While the most significant amount of rubber processing occurs in developed countries, the developing world is processing an increased amount of rubber as these countries build automotive and tire industries. For example, China has rapidly increased synthetic rubber production facilities but still cannot meet demand. As a result, China remains a net importer of synthetic rubber. A profile of the synthetic rubber industry is depicted in figure 1.

The origins of the synthetic rubber industry can be traced back to the mid-1800s when the first laboratory-produced rubber was synthesized by an English scientist. However, it was not until the early 1900s that the properties and advantages of synthetic rubber became widely appreciated. The beginning of World War II brought significant changes to the rubber industry. At that time Southeast Asian countries accounted for 96 percent of world natural rubber production. Exports from those countries were disrupted by the war. Since rubber was deemed a raw material vital to both the U.S. industrial sector and to the war effort, the U.S. Government sought to develop an alternative source of supply through the development of a domestic commercial-size synthetic rubber industry.[1] Because development of the synthetic rubber industry in the United States was a high priority, production facilities were constructed rapidly.

[1] A.D. Roberts, ed., *Natural Rubber Science and Technology* (New York: Oxford University Press, 1988), pp. 9-10.

**Figure 1**
**Synthetic rubber industry: Principal raw materials, producer types, major products, and principal uses**




Source: Compiled by the USITC staff from various sources.

In 1941, U.S. synthetic rubber production capacity was 8,130 mt, but by 1944 the capacity had grown to over 1,000,000mt.[2]

# U.S. INDUSTRY PROFILE

## Product Description and Attributes

Rubbers, or elastomers,[3] refer to a broad group of natural and synthetic materials that are characterized primarily by their ability to return rapidly to their initial dimensions and shape after deformation by stress and the release of stress. Synthetic rubbers, in contrast to natural

[2] Martin Grayson and David Eckroth, eds., *Kirk-Othmer Encyclopedia of Chemical Technology*, 3d ed., vol. 8 (New York: John Wiley & Sons, 1981), p. 453.

[3] Elastomer, a term which is synonymous with rubber, refers to natural and synthetic vulcanizable products which possess elastic properties after crosslinking (vulcanization), can be stretched to at least twice their original length (at room temperature), and, after removal of the tension, will return to their original length. Although the term elastomer has been extended to thermoplastic (uncrosslinked) polymers, this report does not include thermoplastic elastomers. See appendix B for a glossary of industry terms.

rubbers,[4] are defined primarily by their derivation--from petrochemicals by chemical synthesis. Synthetic rubbers, as well as natural rubbers, possess elasticity, a highly polymerized structure, and vulcanizability.[5]

For trade purposes, the term synthetic rubber is defined in the Harmonized Tariff Schedule (HTS) of the United States as including the following:

1. Unsaturated synthetic substances which can be irreversibly transformed by vulcanization with sulfur into non-thermoplastic substances which, at a temperature between 18 and 29 degrees Celsius, will not break on being extended to three times their original length and will return, after being extended to twice their original length, within a period of 5 minutes, to a length not greater than 1½ times their original length. For purposes of this test, substances necessary for the cross-linking, such as vulcanizing activators or accelerators, may be added; the presence of certain substances (including small amounts of breakdown products of emulsifiers and very small amounts of certain agents) is also permitted. However, the presence of any substances not necessary to the cross-linking, such as extenders, plasticizers, and fillers, is not permitted;

2. Thioplasts; and

3. Natural rubber modified by grafting or mixing with plastics, depolymerized natural rubber, mixtures of unsaturated synthetic substances with saturated synthetic high polymers provided that all the above-mentioned products comply with the requirements concerning vulcanization, elongation, and recovery as outlined above.[6]

While there are potentially thousands of chemical entities that can possess rubber-like properties, there are only nine major general purpose and eight major specialty rubbers produced commercially today. The general purpose rubbers are characterized by their large production volumes, relatively low cost, and wide product applicability. Specialty rubbers, on the other hand, are typically produced in small quantities and have unique properties that allow their use in specialized applications (e.g., high heat resistance). The major general purpose and specialty

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[4] Natural rubbers are those obtained or extracted from plant material. For more information on the natural rubber industry see U.S. International Trade Commission (USITC) publication 2741 (*Industry and Trade Summary: Natural Rubber*).

[5] Vulcanizability refers to the conversion of rubber from a predominantly soft, plastic-like material into a strong elastic (rubbery) material. This is accomplished by forming three-dimensional crosslinking between the single molecules to obtain a continuous network of flexible elastic chains. Vulcanization usually requires sulfur and/or heat, although it may also be achieved with certain chemicals, such as organic peroxides.

[6] Headnotes of Chapter 40 of the Harmonized Tariff Schedule of the United States (HTS), p. 40-1.

rubbers are outlined in table 1, with descriptions of six of the more significant materials following later in this report.

**Table 1**
**Synthetic rubber: Major types of rubber produced commercially**

| General Purpose Name | Abbreviation | Specialty Name |
|---|---|---|
| Styrene-butadiene rubber | SBR | Acrylic |
| Styrene-butadiene latex | SBR-latex | Epichlorhydrin |
| Carboxylated styrene-butadiene | XSBR | Propylene oxide |
| Butadiene | BR | Sulfide polymers |
| Ethylene-propylene polymers | EPM or EPDM | Polynorbornene |
| Nitrile (acrylonitrile-butadiene) | NBR | Silicone |
| Isoprene | IR | Fluorinated elastomers |
| Butyl (isobutylene-isoprene) | IIR | Hydrogenated nitrile |
| Chloroprene (neoprene) | CR | |

Source: Compiled by USITC staff from various sources.

# Production Process

There are four basic steps in the production and forming processes for synthetic rubber:

1. Preparation of the elastomer (polymerization);
2. Mixing and blending (compounding) with vulcanizing agents and other rubber-processing chemicals;
3. Shaping or forming by extrusion, coating, calendering, dipping, or molding; and
4. Vulcanization.

Synthetic rubbers are produced by polymerization of basic petrochemical feedstocks. Generally, two or more feedstocks (e.g., butadiene, styrene, and acrylonitrile) are mixed with catalysts, emulsifiers, and other chemical reaction-controlling agents in a reactor vessel. Once the raw rubber is formed (polymerized), further processing is necessary before the material can be turned into a useful product. Typically, the rubber is compounded by the addition of ingredients such as vulcanization agents, accelerators, antioxidants, activators, fillers, plasticizers, pigments (e.g., carbon black), and lubricants.[7] After compounding, the rubber is usually formed or molded into the desired product through three main processing methods--calendering forms sheets or strips by forcing the solid rubber between rollers; extrusion compresses the rubber mixture through a die or orifice and results in sheets or strips; and molding utilizes a preformed mixture of material that is placed in a mold cavity and subsequently compressed to obtain the product. Finally, the product is vulcanized.[8]

[7] See appendix B for a glossary of industry terms.
[8] Ibid.

# Forms of Synthetic Rubber

Synthetic rubber enters commerce in one of three basic forms--latex[9], solid, or powder. The form of synthetic rubber is usually dependent on end-use application. For example, latexes are typically used for articles that are coated or dipped (e.g., fabric coating, rubber gloves). Solid forms are usually processed by extrusion or calendering, and these products are used in tire and rubber goods manufacture. Powder forms are generally used in fine coating applications.

# Types of Synthetic Rubber

As shown in table 1, there are nine major types of general purpose synthetic rubbers produced commercially, each with differing raw material inputs, production methods, physical/chemical properties, and end uses. The most significant of these are discussed below.

## *Styrene-butadiene rubber (SBR)*

Styrene-butadiene rubber is the largest-volume synthetic rubber produced today. It is produced from the monomers styrene and butadiene and is commercially available in three main forms--solid, latex, and carboxylated. The relative proportions of styrene and butadiene can vary but are typically 75 percent butadiene to 25 percent styrene. If the styrene content is less than approximately 50 percent, the resulting polymer is rubbery; however, as styrene content increases beyond 50 percent, the polymer becomes harder, more like a plastic, and less elastic in nature. SBR's main use is in the production of tires, although some may be used in industrial rubber goods such as gaskets and hoses.

## *Butadiene rubber*

Butadiene rubber is the second-largest commercially produced rubber behind SBR. Polymerization of butadiene can result in a number of isomers, but the predominant one in commercial applications is the cis-1,4- structure, which is similar in structure to natural rubber. Butadiene rubber possesses excellent heat and abrasion resistance and good low-temperature properties. It is mainly used in tire and belting applications.

## *Ethylene-propylene rubber*

Ethylene-propylene monomer (EPM) and ethylene-propylene-diene monomer (EPDM) rubbers are similar because they are produced primarily from ethylene and propylene petrochemical raw materials. However, EPDM contains a third monomer, a diene, in addition to ethylene and propylene. Most ethylene-propylene rubbers produced are of the EPDM type. Since their introduction in the United States in the early 1960s, ethylene-propylene rubbers have exhibited

[9] See appendix B.

steady growth in many applications.[10] Ethylene-propylene rubbers are characterized by their outstanding resistance to heat, light, oxygen, and ozone. End uses for ethylene-propylene rubbers are varied, but include tires, automotive components, sheeting, roofing barriers, and hose and belting applications.

## *Nitrile rubber (NBR)*

Nitrile rubber, also known as acrylonitrile-butadiene rubber, is a synthetic rubber produced by the copolymerization of butadiene and acrylonitrile. Nitrile rubber is characterized primarily by a high degree of resistance to petroleum chemicals and by superior flexibility at low temperatures. Thus, it is principally used in applications such as industrial rubber goods (hoses and belting), seals and gaskets, adhesives, footwear, and wire and cable insulation. Nitrile rubber is used in latex as well as solid forms.

## *Butyl (isobutylene-isoprene) rubber*

Butyl rubber is made from the polymerization of isobutylene and a small amount of isoprene to produce polymethylpropene-co-2-methyl-1,3-butadiene. Compared with other rubbers, butyl rubber is distinguished by its high level of impermeability to gases and low thermal expansion. Due to these physical properties, butyl rubber is mainly used in tire applications, especially in the manufacture of inner tubes, tire inner liners, and sidewall construction. Relatively minor end-use applications include rubber mechanical goods, paper coatings, and electrical applications.

## *Chloroprene rubber (Neoprene)*

Polychloroprene is the name for a family of synthetic rubbers based on the chemical chloroprene. The chloroprene rubbers are noted for their high resilience and excellent resistance to ozone deterioration. Additionally, chloroprene rubbers possess strength and resistance to abrasion, chemicals, and aging. As a multipurpose elastomer, chloroprene is used in a wide range of end-use applications. For example, chloroprene rubbers are used in belting, gaskets, hose, wire and cable coverings, and adhesive applications. Chloroprene rubbers are available in both latex and solid forms, but solid forms predominate in the industry.

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[10] Martin Grayson and David Eckroth, eds., *Kirk-Othmer Encyclopedia of Chemical Technology*, 3d ed., vol. 8 (New York: John Wiley & Sons, 1981), p. 492.

# Product Applications

Synthetic rubbers are raw materials used in a diverse group of industries. The most important end-use application, in terms of value and quantity consumed, is the tire industry. Data for 1994, the latest full-year, indicate that 1,196,800 mt, or 51 percent of total U.S. synthetic rubber consumption, were used in tire production.[11] The United States is the largest world tire producer; production in 1994 totaled 244 million car and truck tires.[12] While natural rubber typically accounts for approximately 40 percent of the rubber used in tires, the remaining 60 percent is split among a number of synthetic rubbers. The main synthetics used in tire construction are SBR, butyl, and butadiene rubbers. These rubbers are used in different tire parts, such as the carcass, tread, and sidewall, where the properties of the specific rubber used impart the desired quality and performance in the finished tire product.

Other than in the tire industry, synthetic rubber is used mainly in industrial goods (hose, belting, seals, and gaskets), footwear, adhesives, foam, wire and cable coverings, medical goods, sporting goods, and in coating applications (paper and fabric). Many applications that traditionally employed natural rubber have switched to synthetic rubbers or thermoplastic elastomers in recent years primarily because these synthetic materials offer higher performance, such as better durability and chemical resistance. However, in spite of the numerous markets for synthetic rubber, its demand will continue to be determined predominantly by the demand for tires.

# Industry Structure

Synthetic rubber is produced by four main types of producers--petroleum and natural gas companies, chemical companies, tire companies, and government entities. With the exception of government entities, synthetic rubber producers are large and global in scope--12 firms account for more than 60 percent of world synthetic rubber production.[13] Most synthetic rubber producers are also involved in related upstream or downstream industries. Upstream producers are those that extend at least into the production of raw material monomers, while some are integrated to the point of crude petroleum and natural gas extraction. These producers include major multinational firms such as Exxon, DuPont, and Shell. Downstream producers are those involved in the manufacture of rubber products (mostly tires) in addition to synthetic rubbers. They include companies such as Michelin, Goodyear, and Continental Tire. In a few cases, firms are involved in both upstream and downstream industries (e.g., Japan Synthetic Rubber). While a significant percent of synthetic rubber production is consumed within a company or sold to related parties, some synthetic rubber producers do sell to companies outside of their own corporate structure. U.S. synthetic rubber consumers that are not related to a producing

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[11] International Rubber Study Group, *Rubber Statistical Bulletin*, Wembley, United Kingdom, vol. 50, (Mar. 1996) no. 6, p. 39.

[12] Ibid., pp. 40-41.

[13] Excluding the Commonwealth of Independent States (C.I.S.). The Economist Intelligence Unit, *Rubber Trends*, (London), Dec. 1991, p. 33.

company typically obtain their supply by two basic means--direct purchase from the producer and through compounders and distributors. Some large consumers of rubber purchase the material from exporting companies, wholesalers, or compounders.

# U.S. MARKET

## Consumption

The demand for synthetic rubbers generally depends far more on the overall growth of the economy, frequently mirroring the GNP growth rate, than on price variations. As a petrochemical derivative, synthetic rubber price trends typically follow those of crude petroleum. Figure 2 depicts synthetic rubber pricing trends, as reported by the Producer Price Index (PPI), for 1991-95. As shown, the price of synthetic rubber has gradually increased since 1992 and has tracked the overall price movements in the chemical sector. In 1995, both chemical and synthetic rubber industry prices increased at a substantially higher rate than overall manufacturing industry prices as demand for those products increased in the domestic and foreign markets. According to industry sources, the U.S. chemical industry had experienced rapid growth in production through 1994, with the increased supply bringing only minimal increases in price. However, 1995 production growth slowed down significantly. With production growth at a plateau, and with demand increasing substantially in export markets as a result of a weakened dollar and strengthened foreign economies, prices of chemical and synthetic rubber products rapidly increased from the lower levels of 1993-94.[14]

Specific unit values for the various types of synthetic rubbers are reported for recent years in table 2. These data show similar trends to those in the PPI--overall prices initially declined in 1992, but increased thereafter. Table 2 also shows the relative prices of the various types of rubber; for example, SBR is the lowest-cost material indicated, while the more specialized rubbers in the "all other" category cost approximately three times the price of SBR. The demand for synthetic rubber is driven to a great extent by the growth of downstream industries, most notably the automobile industry, which is a major purchaser of tires,[15] and growth of non-tire rubber applications.

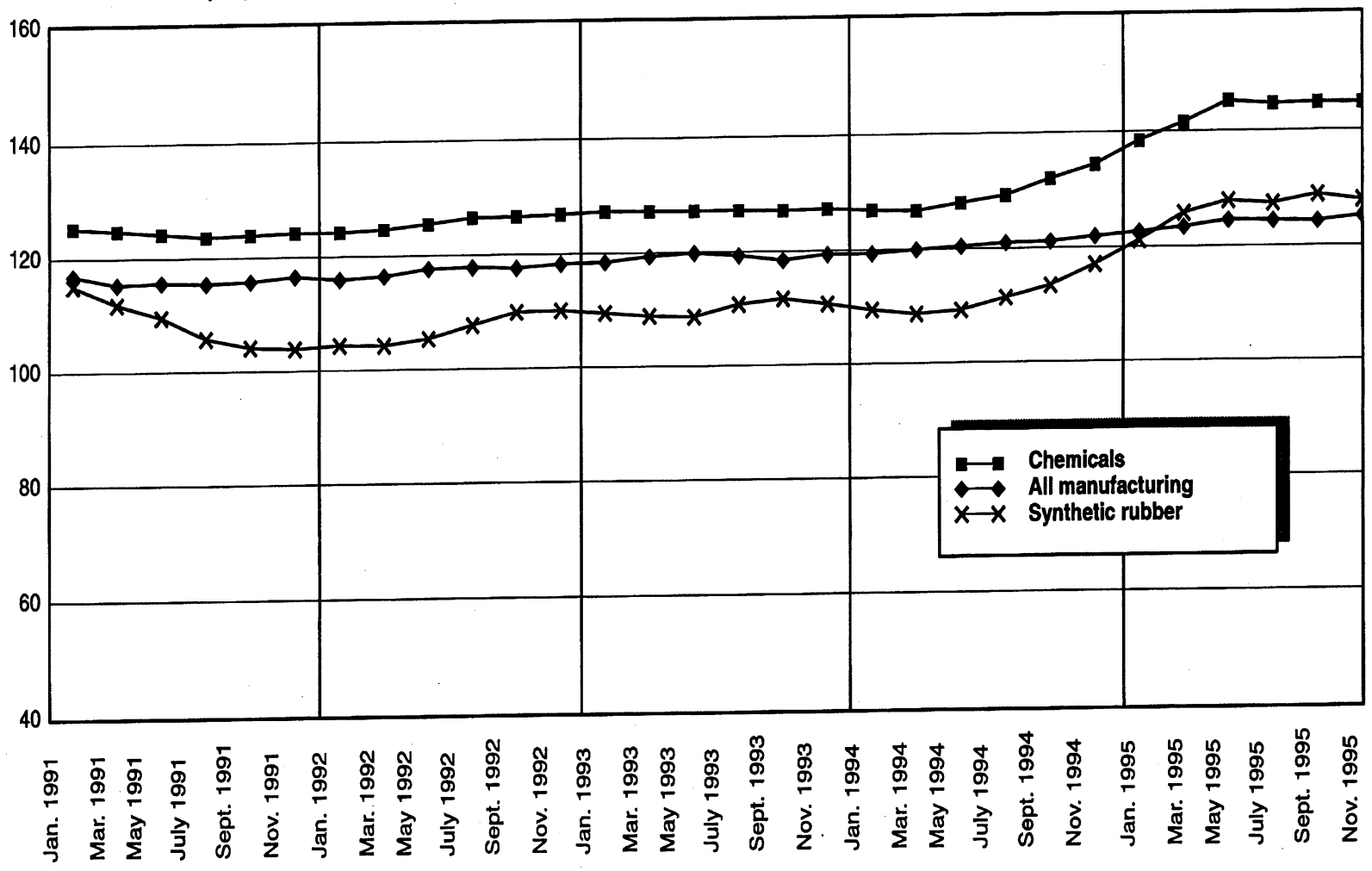
Apparent U.S. consumption of synthetic rubber, in terms of quantity, is shown in table 3. The United States is the world's largest consumer of synthetic rubber, with apparent consumption reaching 2,092,000 mt in 1995. Overall, consumption of synthetic rubber increased during the past 5-year period from a low of 1,737,000 mt in 1991, growing at an average annual rate of 5 percent. This increase was driven primarily by the growth of downstream industries,

[14] William J. Storck, "U.S. Experienced Strong Growth This Year, But 1996 Will Be Weaker," *Chemical & Engineering News,* December 11, 1995, pp. 46-47.

[15] Demand including the replacement market as well as the original equipment market.

**Figure 2**
**U.S. synthetic rubber, chemicals, and total manufacturing pricing trends**

*Price index-not seasonally adjusted*




Source: "Producer Price Index," Bureau of Labor Statistics, U.S. Department of Labor.

**Table 2**
**Synthetic rubber: U.S. production and sales, by type, 1991-94**

| Type | 1991 Production | 1991 Sales quantity | 1991 Sales value | 1991 Unit value | 1992 Production | 1992 Sales quantity | 1992 Sales value | 1992 Unit value |
|---|---|---|---|---|---|---|---|---|
| | *1,000 kg* | | *1,000 $* | *per kg* | *1,000 kg* | | *1,000 $* | *per kg* |
| SBR | 763,542 | 464,090 | 418,066 | 0.90 | 819,836 | 485,328 | 433,661 | 0.89 |
| SBR latex | 130,696 | 133,361 | 160,377 | 1.20 | 196,898 | 198,011 | 239,776 | 1.21 |
| Nitrile | 72,979 | 74,892 | 163,721 | 2.19 | 76,409 | 76,499 | 151,587 | 1.98 |
| Butadiene | 370,713 | 170,120 | 159,823 | 0.94 | 490,163 | 270,357 | 261,751 | 0.97 |
| Ethylene-Propylene | 206,045 | 193,659 | 394,272 | 2.04 | 271,164 | 231,372 | 432,275 | 1.87 |
| All other | 406,870 | 317,222 | 1,147,805 | 3.62 | 451,680 | 345,698 | 1,185,569 | 3.43 |
| Total | 1,950,845 | 1,353,344 | 2,444,064 | 1.81 | 2,306,150 | 1,607,265 | 2,704,619 | 1.68 |

| Type | 1993 Production | 1993 Sales quantity | 1993 Sales value | 1993 Unit value | 1994 Production | 1994 Sales quantity | 1994 Sales value | 1994 Unit value |
|---|---|---|---|---|---|---|---|---|
| | *1,000 kg* | | *1,000 $* | *per kg* | *1,000 kg* | | *1,000 $* | *per kg* |
| SBR | 807,651 | 475,747 | 393,835 | 0.83 | 849,892 | 534,614 | 484,644 | 0.91 |
| SBR latex | 193,903 | 190,809 | 227,782 | 1.19 | (2) | (2) | (2) | (2) |
| Nitrile | 78,808 | 76,285 | 153,402 | 2.01 | 82,743 | 79,332 | 170,607 | 2.15 |
| Butadiene | [1]467,825 | [1]233,451 | [1]217,523 | [1]0.93 | [1]507,680 | [1]256,643 | [1]235,251 | [1]0.92 |
| Ethylene-Propylene | 256,210 | 239,505 | 425,660 | 1.78 | 296,396 | 274,852 | 480,262 | 1.75 |
| All other | 455,768 | 363,257 | 1,293,538 | 3.56 | 554,726 | 507,070 | 1,680,115 | 3.31 |
| Total | 2,260,165 | 1,579,054 | 2,711,740 | 1.72 | 2,291,437 | 1,652,511 | 3,050,879 | 1.85 |

[1] Only includes solution-polymerized butadiene; excludes emulsion-polymerized type which is included in "all other."
[2] Not available.

Source: USITC, *Synthetic Organic Chemicals: U.S. Production and Sales, 1991-94.*

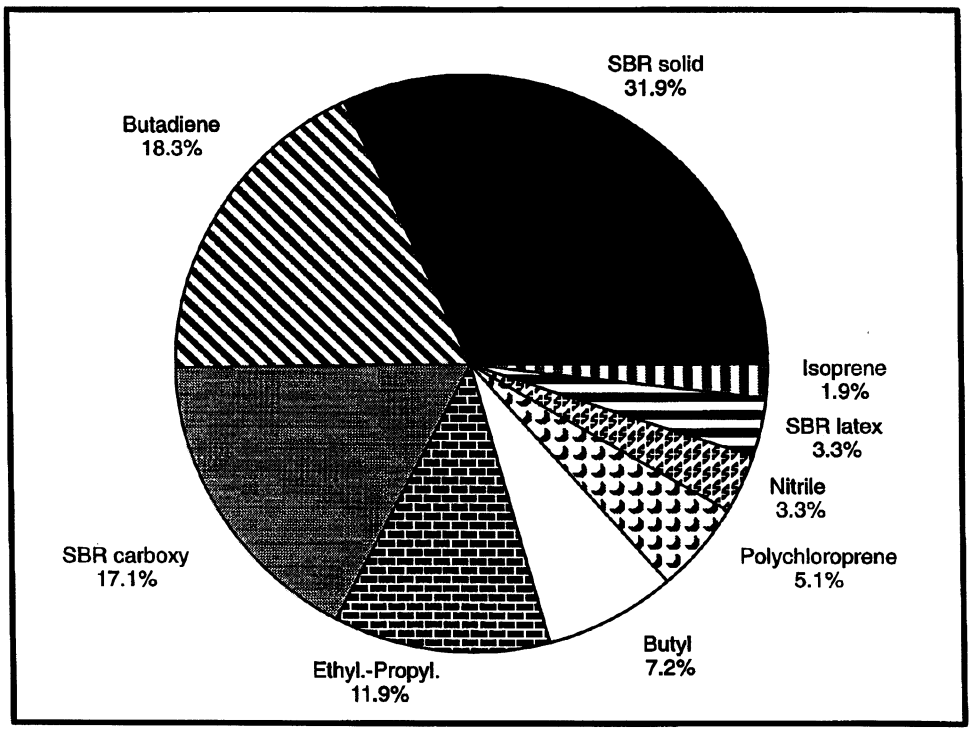
especially the automotive industry and other industrial users. U.S. consumption during this period was mainly supplied by U.S. production.

# Production

Production of synthetic rubber in the United States increased by 18 percent, from 2,050,000 mt to 2,410,000 mt, during 1991-95. The production capacity of synthetic rubber in the United States is dominated by SBR, which accounted for 52 percent of total capacity in 1994, followed by butadiene with 18 percent, and ethylene-propylene with 12 percent (figure 3).

Synthetic rubber is produced in the United States by approximately 20 firms, with plants in about 12 states. Because of the wide availability of petrochemical feedstocks and vertical integration, many plants are located in Texas and Louisiana. Major producers in the United States include Goodyear, Exxon, Firestone, Bayer, DuPont, Dow, Ameripol Synpol, Shell, and Copolymer Rubber. In 1995, approximately 11,000 people were employed by the U.S. synthetic rubber industry.

**Figure 3**
**Synthetic rubber: U.S. production capacity, 1994, by type**




Source: International Rubber Study Group, "Rubber Statistical Bulletin," Wembley, United Kingdom, vol. 50, (Dec. 1995) No. 3, p. 47.

**Table 3**
**Synthetic rubber: U.S. production, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1991-95**

| Year | Production | Exports | Imports | Apparent consumption | Ratio of imports to consumption |
|---|---|---|---|---|---|
| | *1,000 metric tons* | | | | *Percent* |
| 1991 | 2050 | 596 | 283 | 1737 | 16.3 |
| 1992 | 2300 | 697 | 325 | 1928 | 16.9 |
| 1993 | 2180 | 631 | 344 | 1892 | 18.2 |
| 1994 | 2390 | 730 | 416 | 2076 | 20.0 |
| 1995 | 2410 | 746 | 429 | 2092 | 20.5 |

Note.—Import data during 1991-93 and export data during 1991-95 do not include HTS 4002.31.00 (isobutene-isoprene rubber) because there was no unit of quantity specified for data collection. Production data for 1995 are estimated.

Source: Production data are obtained from International Rubber Study Group, *Rubber Statistical Bulletin*, Wembley, United Kingdom, Vol. 50, No. 6 (March 1996), p. 28. Import and export data obtained from official statistics of the U.S. Department of Commerce.

# U.S. TRADE

## Overview

The United States experienced an average annual trade surplus of $551 million for synthetic rubber during 1991-95 (table 4). As shown in figure 4, the U.S. trade balance during this period increased from $523 million in 1991 to $648 million in 1995. In general, this increase was due to rising consumer demand for end-use products such as tires, hose, and belting in foreign markets.

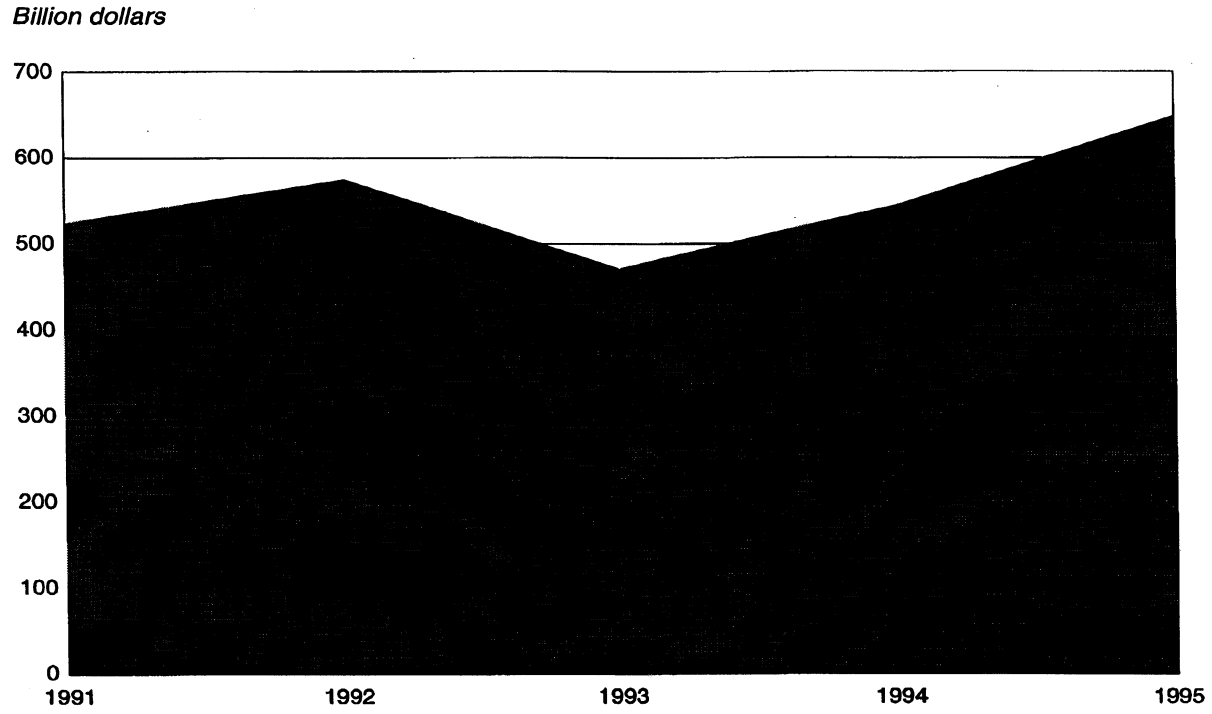
There were, however, exceptions during this period. For example, Germany experienced an economic downturn in 1993, which placed increased pressure on German producers of synthetic rubbers to export their products to other markets, i.e., the United States. As a result, the United States had a negative trade balance with Germany in 1993. Despite an economic upturn in Germany, this negative trade balance continued in 1994-95, primarily because of increased demand for these products by the U.S. subsidiaries of German producers. According to industry sources, some of these subsidiaries are being used as sourcing locations for other plants located throughout the world, which would indicate that negative trade balances with Germany may continue.

**Table 4**
**Synthetic rubber: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 1991-95[1]**

| *(Million dollars)* | | | | | |
|---|---|---|---|---|---|
| **Item** | **1991** | **1992** | **1993** | **1994** | **1995** |
| *U.S. exports of domestic merchandise:* | | | | | |
| Canada | 220 | 242 | 260 | 307 | 348 |
| Belgium | 173 | 193 | 138 | 176 | 216 |
| Japan | 57 | 68 | 86 | 91 | 87 |
| Mexico | 73 | 81 | 67 | 90 | 83 |
| Brazil | 68 | 56 | 74 | 89 | 80 |
| France | 51 | 70 | 51 | 52 | 61 |
| United Kingdom | 28 | 37 | 42 | 45 | 48 |
| Netherlands | 37 | 37 | 29 | 36 | 41 |
| South Korea | 24 | 32 | 25 | 25 | 41 |
| Germany | 32 | 30 | 23 | 29 | 35 |
| All other | 227 | 245 | 230 | 233 | 323 |
| Total exports | 991 | 1092 | 1024 | 1172 | 1364 |
| *U.S. imports for consumption:* | | | | | |
| Canada | 181 | 215 | 231 | 259 | 275 |
| Belgium | 19 | 30 | 37 | 24 | 28 |
| Japan | 56 | 60 | 67 | 77 | 86 |
| Mexico | 22 | 28 | 33 | 39 | 48 |
| Brazil | 2 | 2 | 2 | 3 | 15 |
| France | 47 | 42 | 40 | 47 | 52 |
| United Kingdom | 10 | 11 | 19 | 24 | 25 |
| Netherlands | 28 | 17 | 10 | 12 | 9 |
| South Korea | 6 | 8 | 9 | 12 | 12 |
| Germany | 23 | 28 | 40 | 51 | 58 |
| All other | 189 | 184 | 185 | 227 | 265 |
| Total imports | 468 | 519 | 556 | 629 | 716 |
| *U.S. merchandise trade balance:* | | | | | |
| Canada | 39 | 27 | 28 | 48 | 73 |
| Belgium | 154 | 163 | 101 | 152 | 188 |
| Japan | 2 | 7 | 19 | 13 | 2 |
| Mexico | 52 | 53 | 34 | 51 | 35 |
| Brazil | 66 | 53 | 72 | 86 | 65 |
| France | 4 | 28 | 11 | 5 | 9 |
| United Kingdom | 18 | 26 | 23 | 21 | 24 |
| Netherlands | 9 | 21 | 18 | 25 | 32 |
| South Korea | 18 | 24 | 16 | 13 | 29 |
| Germany | 9 | 3 | -18 | -22 | -23 |
| All other | 38 | 62 | 45 | 6 | 58 |
| Total | 523 | 573 | 469 | 543 | 648 |

[1] Import values are based on customs value; export values are based on f.a.s. value, U.S. port of export.
Source: Compiled from official statistics of the U.S. Department of Commerce.

**Figure 4**
**Synthetic rubber: U.S. trade balance, 1991-95**




Source: Compiled from official statistics of the U.S. Department of Commerce.

# U.S. Imports

## *Principal Suppliers and Import Levels*

Imports grew steadily during 1991-95 and accounted for almost 21 percent of U.S. consumption in 1995. Overall, imports grew at an average annual rate of 11 percent (in terms of value) during this period (table 5). Imports in 1991 totaled $468 million and reached $716 million (429 million mt) in 1995.

The product mix of imported synthetic rubber is similar to that of the rubbers produced in the United States. In 1995, the major import item was SBR ($118 million), followed by butadiene rubber and butyl rubber (both $95 million). The major import source, accounting for approximately 40 percent of total imports during the period, was Canada. Japan was the second major supplier, followed by a number of countries from the European Union (EU). A significant trend in import trade is the increase in products from Russia. In 1992 imports were small but rose steadily throughout the period, reaching $36 million in 1995.[16]

[16] 1991 import data for Russia may have been reported under the Soviet Union.

**Table 5**
**Synthetic rubber: U.S. imports for consumption, by principal sources, 1991-95[1]**

| Source | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|
| | | | *Quantity (1,000 kilograms)* | | |
| Canada | 93,382 | 113,226 | 121,126 | 168,615 | 170,372 |
| Japan | 36,577 | 38,915 | 44,954 | 47,601 | 42,120 |
| Germany | 11,159 | 15,368 | 24,305 | 28,979 | 29,048 |
| France | 25,962 | 26,231 | 25,145 | 32,072 | 27,716 |
| Mexico | 22,515 | 30,329 | 34,661 | 40,115 | 39,512 |
| Russia | (2) | 1,903 | 4,151 | 6,756 | 23,537 |
| Italy | 35,339 | 37,212 | 21,703 | 18,966 | 17,917 |
| Belgium | 10,670 | 13,133 | 16,094 | 14,316 | 15,822 |
| United Kingdom | 6,443 | 6,166 | 8,497 | 9,502 | 8,461 |
| Brazil | 1,313 | 2,777 | 2,865 | 2,841 | 13,105 |
| All other | 39,703 | 39,799 | 40,354 | 45,853 | 41,034 |
| Total imports | 283,063 | 325,059 | 343,855 | 415,616 | 428,644 |
| | | | *Value (1,000 dollars)* | | |
| Canada | 181,316 | 214,652 | 231,476 | 258,873 | 274,906 |
| Japan | 55,849 | 60,486 | 67,072 | 77,495 | 85,503 |
| Germany | 23,023 | 27,513 | 40,222 | 50,813 | 58,435 |
| France | 47,176 | 42,428 | 40,317 | 47,222 | 52,159 |
| Mexico | 21,559 | 27,993 | 33,273 | 38,706 | 47,682 |
| Russia | (2) | 23,701 | 6,217 | 15,841 | 35,651 |
| Italy | 47,591 | 49,341 | 30,954 | 30,638 | 32,084 |
| Belgium | 18,580 | 29,870 | 36,841 | 23,778 | 27,539 |
| United Kingdom | 9,950 | 11,273 | 19,420 | 24,182 | 24,580 |
| Brazil | 1,718 | 2,336 | 2,148 | 2,966 | 15,354 |
| All other | 61,271 | 49,443 | 47,794 | 58,156 | 62,068 |
| Total imports | 468,033 | 519,036 | 555,734 | 628,670 | 715,961 |
| | | | *Unit value (dollars per kilogram)* | | |
| Canada | 1.94 | 1.90 | 1.91 | 1.54 | 1.61 |
| Japan | 1.53 | 1.55 | 1.49 | 1.63 | 2.03 |
| Germany | 2.06 | 1.79 | 1.65 | 1.75 | 2.01 |
| France | 1.82 | 1.62 | 1.60 | 1.47 | 1.88 |
| Mexico | 0.96 | 0.92 | 0.96 | 0.96 | 1.21 |
| Russia | (2) | 1.94 | 1.50 | 2.34 | 1.51 |
| Italy | 1.35 | 1.33 | 1.43 | 1.62 | 1.79 |
| Belgium | 1.74 | 2.27 | 2.29 | 1.66 | 1.74 |
| United Kingdom | 1.54 | 1.83 | 2.29 | 2.55 | 2.91 |
| Brazil | 1.31 | 0.84 | 0.75 | 1.04 | 1.17 |
| All other | 1.54 | 1.24 | 1.18 | 1.27 | 1.51 |
| Average | 1.65 | 1.60 | 1.62 | 1.51 | 1.67 |

[1] Quantity data for 1991-93 do not include HTS subheading 4002.31.00.
[2] Imports from Russia may have been reported under the Soviet Union.

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce.

## *U.S. Trade Measures*[17]

U.S. tariff measures and recent U.S. Government trade-related investigations are discussed below. There are no known nontariff import restrictions specifically relevant to synthetic rubber.

### *Tariff measures*

The majority of synthetic rubber products enter the United States duty free. As shown in table 6, synthetic rubber in primary forms and compounded rubber enter duty free, while rubber in "other forms" (e.g., rods, tubes) has duty rates ranging from 2.5 to 4.6 percent. Imports of rubber in "other forms" are eligible for preferential duty treatment under special import provisions. Specifically, goods from Mexico, Israel, beneficiary countries under the Generalized System of Preferences (GSP), Andean Pact countries, and Caribbean Basin countries are eligible for duty-free treatment, while imports from Canada currently have duty rates ranging from 0.8 to 1.1 percent. These duty rates for Canada are being staged down to "free" under the provisions of the United States-Canada Free Trade Agreement (CFTA).

Because most of the products covered in this report already have duty-free status, there were few tariff concessions as a result of the GATT Uruguay Round (UR) of Trade Agreements. The three tariff lines under rubber in "other forms" were, however, moderately reduced as a result of the UR. The duty rate for "camel-back" strips for tire retreading is being reduced over a 5-year period from 5.8 percent to 2.9 percent. The duty rate on products made of natural rubber falling under this "other forms" category is being reduced to duty-free over a 5-year period, and the duty rate on products other than natural rubber (i.e., synthetic rubber) in the same category is being reduced to 2.7 percent from 5.3 percent over five years.

### *U.S. Government trade-related investigations*

The Commission has conducted two investigations in recent years with respect to synthetic rubber products. In April 1988, the Commission made a final affirmative determination under the U.S. antidumping laws with respect to imports of nitrile rubber from Japan, following notification from the U.S. Department of Commerce that it had found nitrile rubber was being sold in the United States at less than fair value.[18] As a result of the Commission's determination, Commerce issued an antidumping order; imports of nitrile rubber from Japan are subject to special duties, in the amount equal to a weighted average margin of 146.5 percent .[19]

Also, in the late 1980s, the Commission made a negative preliminary determination under the U.S. antidumping laws with respect to polychloroprene imports from France and the Federal Republic of Germany. The Commission determined in November 1989 that "there was no

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[17] See app. A for explanation of tariff and trade agreement terms.

[18] U.S. International Trade Commission, *Nitrile Rubber from Japan* (investigation No. 731-TA-384 (final)), USITC publication 2090, June 1988.

[19] 53 F.R. 15436.

**Table 6**
**Synthetic rubber: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1996; U.S. exports, 1995; and U.S. imports, 1995**

| HTS subheading | Description | Col. 1 rate of duty as of Jan. 1, 1996 | | U.S. exports, 1995 | U.S.imports, 1995 |
|---|---|---|---|---|---|
| | | General | Special ([1]) | Million dollars | |
| | Synthetic rubber and factice derived from oils, in primary forms or in plates, sheets or strip; mixtures of any product of heading 4001 with any product of this heading, in primary forms or in plates, sheets or strip: | | | | |
| | Styrene-butadiene rubber (SBR); carboxylated styrene-butadiene rubber (XSBR): | | | | |
| 4002.11.00 | Latex | Free | | 52 | 40 |
| 4002.19.00 | Other | Free | | 301 | 118 |
| 4002.20.00 | Butadiene rubber (BR) | Free | | 149 | 95 |
| | Isobutene-isoprene (butyl) rubber (IIR); halo-isobutene-isoprene (CIIR or BIIR): | | | | |
| 4002.31.00 | Isobutene-isoprene (butyl) rubber (IIR) | Free | | 16 | 31 |
| 4002.39.00 | Other | Free | | 65 | 95 |
| | Chloroprene (chlorobutadiene) rubber (CR): | | | | |
| 4002.41.00 | Latex | Free | | 5 | 16 |
| 4002.49.00 | Other | Free | | 108 | 22 |
| | Acrylonitrile-butadiene rubber (NBR): | | | | |
| 4002.51.00 | Latex | Free | | 3 | 1 |
| 4002.59.00 | Other | Free | | 72 | 42 |
| 4002.60.00 | Isoprene rubber (IR) | Free | | 40 | 14 |
| 4002.70.00 | Ethylene-propylene-nonconjugated diene rubber (EPDM) | Free | | 152 | 48 |
| 4002.80.00 | Mixtures of any product of heading 4001 with any product of this heading | Free | | 1 | 4 |
| | Other: | | | | |
| 4002.91.00 | Latex | Free | | 11 | 19 |
| 4002.99.00 | Other | Free | | 192 | 63 |
| | Compounded rubber, unvulcanized, in primary forms or in plates, sheets or strip: | | | | |
| 4005.10.00 | Compounded with carbon black or silica | Free | | 94 | 45 |
| 4005.20.00 | Solutions; dispersions other than those of subheading 4005.10 | Free | | 4 | 1 |

Table continued on next page.

**Table 6—*Continued***

**Synthetic rubber: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1996; U.S. exports, 1995; and U.S. imports, 1995**

| HTS subheading | Description | Col. 1 rate of duty as of Jan. 1, 1996 | | U.S. exports, 1995 | U.S.imports, 1995 |
|---|---|---|---|---|---|
| | | General | Special ([1]) | Million dollars | |
| | Other: | | | | |
| 4005.91.00 | Plates, sheets, and strip | Free | | 34 | 25 |
| 4005.99.00 | Other | Free | | 28 | 20 |
| | Other forms (for example, rods, tubes and profile shapes) and articles (for example, discs and rings), of unvulcanized rubber: | | | | |
| 4006.10.00 | "Camel-back" strips for retreading rubber tires | 4.6% | Free (A*,E,IL,J,MX); 1.1% (CA) | 26 | ([3]) |
| | Other: | | | | |
| 4006.90.10 | Of natural rubber | 2.5% | Free (A,E,IL,J,MX); 0.8% (CA) | 12 | 5 |
| 4006.90.50 | Other | 4.3% | Free (A,E,IL,J,MX); 1% (CA) | ([2]) | 11 |

[1] Programs under which special tariff treatment may be provided, and the corresponding symbols for such programs as they are indicated in the "Special" subcolumn, are as follows: Generalized System of Preferences (A) or (A*); Goods of Canada under the terms of the North American Free Trade Agreement (NAFTA) (CA); Caribbean Basin Economic Recovery Act (E); United States-Israel Free Trade Area (IL); Andean Trade Preference Act (J); and Goods of Mexico under the terms of the NAFTA (MX).

[2] U.S. exports under Schedule B subheading 4006.90.00 are equivalent to aggregate imports reported under HTS subheadings 4006.90.10 and 4006.90.50. Value included under HTS subheading 4006.90.10.

[3] Less than $500,000 in imports.

Source: USITC, Harmonized Tariff Schedule of the United States (1996). Exports and imports compiled from official statistics of the U.S. Department of Commerce.

reasonable indication that an industry in the United States is materially injured or threatened with material injury, or that the establishment of an industry in the United States is materially retarded."[20]

# U.S. Exports

## *Principal Markets and Export Levels*

Major foreign markets for synthetic rubber include the major producing countries of tires and other rubber goods. The major markets for U.S. products during 1991-95 were Canada, the EU, and Japan. Little detailed statistical information is available for foreign markets; however, the market breakdown for Japan is detailed in table 7. In general, the typical markets throughout

**Table 7**
**Synthetic rubber: The market in Japan, 1993-94**
*(Metric tons)*

| Application | 1993 | 1994 |
|---|---|---|
| Rubber tires and tube | | |
| Automobile | 921,090 | 928,880 |
| Bicycle and cart | 11,250 | 10,870 |
| Bicycle | 7,880 | 7,340 |
| Cart | 3,370 | 3,530 |
| Miscellaneous | 5,320 | 5,350 |
| Compounded rubber for retread & repair | 11,820 | 12,990 |
| Subtotal | 949,480 | 958,090 |
| | | |
| Industrial rubber goods | | |
| Rubber belting | 28,960 | 28,200 |
| Rubber hoses | 28,850 | 31,720 |
| Miscellaneous | 219,160 | 208,210 |
| Subtotal | 276,970 | 268,130 |
| | | |
| Other rubber goods | | |
| Rubber shoes | 19,910 | 18,820 |
| Rubber coated cloth | 3,550 | 3,270 |
| Medical supplies | 5,160 | 5,000 |
| Sporting goods | 6,980 | 5,600 |
| Miscellaneous | 30,450 | 28,090 |
| Subtotal | 66,050 | 60,780 |
| Total | 1,292,500 | 1,287,000 |

Source: The Chemical Daily Co., *Japan Chemical Annual, 1994 and 1995*, Tokyo, Japan, pp. 53-55.

[20] U.S. International Trade Commission, *Polychloroprene from France and the Federal Republic of Germany* (investigations Nos. 731-TA-446 and 447 (preliminary)), USITC publication 2233, Nov. 1989.

the world for synthetic rubber are tires, tubes, industrial rubber goods (e.g., hoses, belting), and miscellaneous goods such as footwear and coated fabrics.

During 1991-95, U.S. exports of synthetic rubber averaged $1.13 billion annually (table 8). Overall, U.S. exports of synthetic rubber increased steadily during this period from $991 million in 1991 to $1.36 billion in 1995, or by 38 percent. According to industry sources, the majority of these exports are believed to be intracompany transfers among multinational tire/chemical companies. Companies such as Goodyear, Bridgestone/Firestone, Michelin, and Continental/General Tire have tire production operations in neighboring countries--Canada, Mexico, and other Central and South American countries.

**Table 8**
**Synthetic rubber: U.S. exports by principal markets, 1991-95**

*(1,000 dollars)*

| Market | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|
| Canada | 219,946 | 241,569 | 259,734 | 306,851 | 347,971 |
| Belgium | 173,035 | 193,299 | 137,634 | 175,601 | 215,840 |
| Japan | 57,408 | 67,687 | 85,963 | 90,688 | 87,396 |
| Mexico | 73,424 | 80,670 | 67,411 | 90,060 | 82,829 |
| Brazil | 68,137 | 55,665 | 74,297 | 88,877 | 80,264 |
| France | 51,373 | 70,001 | 51,303 | 52,199 | 60,937 |
| United Kingdom | 27,948 | 37,351 | 42,054 | 44,686 | 48,233 |
| Netherlands | 37,114 | 37,396 | 28,522 | 36,215 | 41,344 |
| South Korea | 23,634 | 32,326 | 25,140 | 24,821 | 40,650 |
| Germany | 32,207 | 30,354 | 22,676 | 28,714 | 35,447 |
| All other | 226,529 | 245,307 | 229,602 | 232,935 | 323,461 |
| Total exports | 990,755 | 1,091,625 | 1,024,336 | 1,171,647 | 1,364,372 |

Source: Compiled from official statistics of the U.S. Department of Commerce.

The major export markets for synthetic rubber during this period were Canada, Belgium, and Japan. Due to increased demand from Canadian end users, exports to Canada exhibited tremendous growth during this period, increasing 58 percent by value. The major products exported include SBR ($301 million), followed by "other synthetic rubber" ($192 million), and ethylene-propylene rubber ($152 million).

## *Foreign Trade Measures*

Major U.S. trading partners in synthetic rubber generally apply equivalent duty-free treatment for synthetic rubber in primary forms and minimal tariffs for compounded rubber and rubber in "other forms." As shown in table 9, U.S. exports of rubber under HTS subheading 4002 (primary forms) encounter duty-free treatment in Canada, Japan, and the European Union. Although Canada has relatively high (8.9 percent) MFN tariffs on products in HTS subheadings 4005 ("compounded rubber, unvulcanized, in primary forms or in plates, sheets or strip") and 4006 ("other forms . . . and articles . . . of unvulcanized rubber"), U.S. exports are granted

preferential duty treatment under the terms of the CFTA. The current tariff rates for Japan and the EU are minimal, and they will be further reduced as a result of the tariff concessions agreed to during the UR.

**Table 9**
**Synthetic rubber: Tariff rates for major trading nations, 1996**

| | *(Percent)* | | |
|---|---|---|---|
| | **HS subheading** | | |
| **Nation/Area** | **4002** | **4005** | **4006** |
| Canada | Free | 8.9 | 8.9 |
| European Union | Free ([1]) | 1.5 ([2]) | 1.5 |
| Japan | Free | 2.9 ([3]) | 2.9 |

[1] Exception—4002.99.10 has a duty rate of 3.4 percent.
[2] Exception—4005.99.00 has a duty rate of "free."
[3] Exception—a breakout for natural rubber under 4005.99 has a duty rate of "free."
Source: Compiled from country tariff schedules.

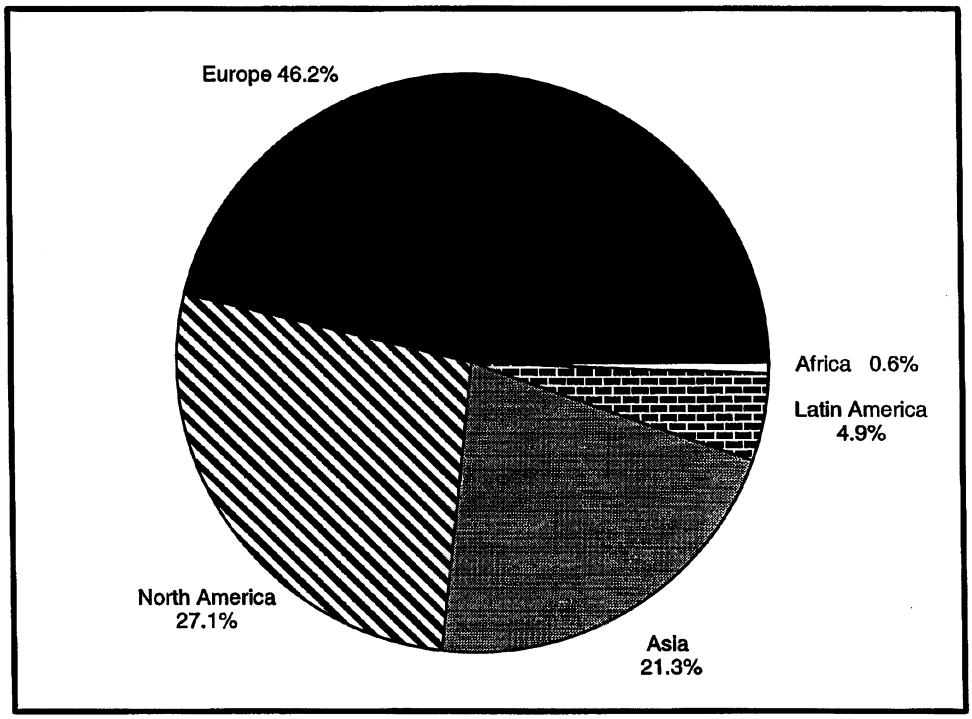
# FOREIGN INDUSTRY PROFILE

## Overview

The synthetic rubber industry is a global industry with numerous multinationals producing in various countries throughout the world. In addition to the United States, which is the world's largest producer, major producers include the European Union, Japan, and Russia/Commonwealth of Independent States (CIS). Figure 5 shows world capacities by region. Due to the global nature of chemicals, tires, and petroleum. Major world producers of synthetic rubber include Exxon, Nippon Zeon, Enichem Elastomeri (Italian government-owned), Goodyear, and Bayer. Table 10 outlines the major production capacity in the world by country and by type of rubber.

One of the most significant events to occur in the synthetic rubber industry during the past 5 years has been the displacement of Russia/CIS as the second largest world producer of synthetic rubber. During the cold war, the Soviet Union reported production capacities equal to or greater than those in the United States, with production almost exclusively concentrated in Russia. While most countries use blends of natural and synthetic rubber in many rubber goods applications, Soviet producers relied almost totally on synthetic rubber, importing only small amounts of natural rubber. In fact, Russia's 1991 synthetic rubber production was greater than U.S. production for the same year. However, with recent widespread changes in the Russian/CIS economy, synthetic rubber production has plummeted in Russia (table 11). As

**Figure 5**
**Synthetic rubber: World capacities, 1994, by region**




Source: International Rubber Study Group, "Rubber Statistical Bulletin," Wembley, United Kingdom, vol. 50, (Dec. 1995) No. 3, p. 47.

reported by one source, high production costs have forced the conversion of three Russian synthetic rubber plants into facilities for the production of MTBE (methyl tert-butyl ether), a gasoline additive.[21]

While synthetic rubber production is concentrated in the developed world, developing countries, most notably China and several Latin American countries, have increased their capacities. As shown in table 11, developed countries such as Japan tend to be net exporters (i.e., production exceeds consumption), while developing countries are usually net importers (i.e., consumption exceeds production). With the exception of Russia and some East European countries, production by the world's major producers has steadily increased in recent years.

[21] Natasha Alperowicz, "Russian Rubber Producers Convert Plants to MTBE," *Chemical Week*, May 25, 1995, p. 26.

**Table 10**
**Synthetic rubber: World capacities 1994, by type**

| Country | SBR solid | SBR latex | SBR carboxy. | Butadiene | Isoprene | Ethyl.-Propyl. | Butyl | Nitrile | Polychlorop. | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| North America | | | | | | | | | | |
| Canada | 20 | | 37 | 63 | | | 120 | 25 | | 265 |
| United States | 1,021 | 105 | 547 | 587 | 61 | 381 | 230 | 107 | 163 | 3,202 |
| Latin America | | | | | | | | | | |
| Argentina | 54 | 8 | 11 | | | | | 2 | | 75 |
| Brazil | 277 | 6 | 22 | 70 | | 14 | | 17 | | 406 |
| Mexico | 95 | 2 | 17 | 20 | | | | 7 | | 141 |
| Europe | | | | | | | | | | |
| Austria | | | 6 | | | | | | | 6 |
| Belgium | 20 | | 15 | 20 | | | 95 | | | 150 |
| Bulgaria | 20 | 15 | | | | | | | | 35 |
| Czech Republic | 75 | 10 | | | | | | | | 85 |
| Finland | | | 89 | | | | | | | 89 |
| France | 114 | 48 | 87 | 155 | | 80 | 53 | 46 | 40 | 623 |
| Germany | 75 | 62 | 202 | 96 | | 41 | | 60 | 60 | 596 |
| Italy | 135 | 20 | 65 | 80 | | 85 | | 40 | | 425 |
| Netherlands | 115 | 23 | 75 | | 30 | 70 | | 15 | | 328 |
| Poland | 112 | 6 | | | | | | | | 118 |
| Romania | 100 | | | 60 | 91 | | 5 | | | 256 |
| Spain | 50 | | 21 | 25 | | | | | | 96 |
| Sweden | | | 32 | | | | | | | 32 |
| Turkey | 27 | | | 14 | | | | | | 41 |
| United Kingdom | 165 | 35 | 93 | | | | 69 | 15 | 33 | 410 |
| C.I.S. | 690 | 120 | | 413 | 1,130 | | 85 | 40 | 100 | 2,578 |
| Former Yugoslavia | 40 | 8 | | | | | | | | 48 |
| Australia | 35 | 4 | 12 | 12 | | | | | | 63 |
| China | 120 | | | 95 | | | | 12 | 20 | 247 |
| India | 45 | 1 | | 18 | | 10 | | 2 | | 76 |
| Japan | 655 | 108 | 131 | 306 | 67 | 200 | 105 | 111 | 88 | 1,771 |
| South Korea | 180 | | 52 | 90 | | 20 | | 10 | | 352 |
| Taiwan | 120 | 27 | 10 | 48 | | | | 16 | | 221 |
| Africa | | | | | | | | | | |
| South Africa | 50 | 5 | 7 | 18 | | | | 1 | | 81 |
| Total | 4,410 | 613 | 1,531 | 2,190 | 1,379 | 901 | 762 | 526 | 504 | 12,816 |

Source: International Rubber Study Group, *Rubber Statistical Bulletin*, Wembley, United Kingdom, vol. 50, (Dec.1995) No. 3, p. 47.

**Table 11**
**Synthetic rubber: World production and consumption, by country, 1991-95**

*(1,000 metric tons)*

| | 1991 | | 1992 | | 1993 | | 1994 | | 1995 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | Production | Consumption | Production | Consumption | Production | Consumption | Production | Consumption | Production | Consumption |
| Canada | 180 | 183.9 | 206 | 198 | 197 | 210 | 232 | 240 | 230 | 240 |
| United States | 2,050 | 1,768.1 | 2,300 | 1,959.6 | 2,180 | 2,001 | 2,390 | 2,117.6 | 2,410 | 2,200 |
| Argentina | 40.9 | (1) | 41.8 | (1) | 43.8 | (1) | 48.8 | (1) | 53.6 | (1) |
| Brazil | 264 | 290.3 | 261.3 | 297.4 | 268.1 | 285 | 280 | 288 | 300 | 297 |
| Mexico | 117.7 | 115 | 130.8 | 125 | 123.3 | 130 | 122.1 | 96 | 120 | 96 |
| Austria | 5 | (1) | 5 | (1) | 5 | (1) | 5 | (1) | 5 | (1) |
| Belgium | 114 | 75 | 120 | 79 | 120 | 78.5 | 126 | 80 | 127 | 81 |
| Finland | 30 | (1) | 32 | (1) | 32 | (1) | 33 | (1) | 35 | (1) |
| France | 470.7 | 342 | 500.4 | 365.4 | 486.3 | 314.7 | 520.3 | 325.2 | 546 | 350 |
| Germany | 504.4 | 502 | 544.7 | 506 | 569.7 | 488 | 642 | 535 | 487.5 | 514 |
| Italy | 305 | 305 | 310 | 295 | 300 | 280 | 305 | 285 | 297 | 285 |
| Netherlands | 245.5 | (1) | 190.5 | (1) | 176.4 | (1) | 209.3 | (1) | 196 | (1) |
| Spain | 64.9 | 147 | 72.2 | 165 | 77.8 | 146.8 | 76 | 171.2 | 77 | 164 |
| Sweden | 34.8 | (1) | 34.2 | (1) | 28 | (1) | 29 | (1) | 30 | (1) |
| United Kingdom | 251.3 | 201 | 280.1 | 231 | 289.8 | 212 | 290.7 | 217 | 319.8 | 218 |
| Bulgaria | 10.6 | (1) | 16.2 | (1) | 17.2 | (1) | 20.6 | (1) | 20 | (1) |
| Czech Republic | 44.9 | 68 | 70.2 | 81 | 57.3 | 50 | 74 | 40 | 79 | 49 |
| Poland | 79.5 | 52.6 | 88.9 | 61.9 | 75.1 | 60 | 83.4 | 74.1 | 104.8 | 81 |
| Romania | 54.7 | 60 | 35.9 | 48 | 33.2 | 62 | 26.2 | 48 | 41.6 | 52 |
| Russia[2] | 2,105 | 1,980 | 1,495 | 1,130 | 1,030 | 720 | 590 | 360 | 780 | 525 |
| Turkey | 34.3 | 56 | 28.7 | 71 | 37.7 | 82 | 42.6 | 60 | 48 | 80 |
| Former Yugoslavia | 7.4 | (1) | (1) | (1) | (1) | (1) | (1) | (1) | (1) | (1) |
| Other Europe | (1) | (1) | 125 | (1) | 75 | (1) | 45 | (1) | 47 | (1) |
| South Africa | 34.9 | 47 | 33.5 | 44 | 35.1 | 47 | 51 | 61 | 62 | 69 |
| Australia | 35.5 | 51 | 39.9 | 53 | 46.4 | 62 | 44.6 | 68.7 | 48.2 | 69 |
| China | 334.7 | 410 | 371.2 | 515 | 385.3 | 545 | 493.6 | 700 | 492.6 | 785 |
| India | 55.5 | 100.4 | 60.6 | 110.2 | 53.1 | 110.6 | 58.5 | 116.2 | 59 | 135 |
| Japan | 1,377.3 | 1,118.5 | 1,389.9 | 1,080.6 | 1,309.8 | 1,022 | 1,349 | 1,026.2 | 1,398 | 1,052 |
| Korea | 225 | 251.2 | 260 | 275.3 | 307.2 | 307 | 339.7 | 320 | 370 | 345 |
| Taiwan | 193.6 | 206 | 197.5 | 215 | 214.6 | 209 | 297.2 | 278 | 346 | 288 |
| Total | 9,271.1 | 8,330 | 9,241.5 | 7,906.4 | 8,574.2 | 7,422.6 | 8,824.6 | 7,507.2 | 9,130.1 | 7,975 |

[1] Not available.
[2] Data prior to 1992 refer to the former U.S.S.R.

Note.—Most data for 1995 are estimated.

Source: International Rubber Study Group, *Rubber Statistical Bulletin*, Wembley, United Kingdom, Vol. 50, No. 6 (March 1996), pp. 28-36.

# Japan

With the significant decrease in synthetic rubber production in Russia in recent years, Japan has become the second largest synthetic rubber producer in the world (table 11) and has maintained the second largest production capacity (table 10) of an individual country after the United States. Japan's synthetic rubber industry is similar in structure to that of the United States, with extensive SBR capacity and production of all types of general purpose rubbers and many of the specialty rubbers (table 12). During 1991-94, Japanese production continually outstripped their consumption (table 11), and Japan, like the United States, has remained a significant net exporter of synthetic rubber.

**Table 12**
**Synthetic rubber: Production in Japan, by type, 1991-94**

*(Metric tons)*

| Type | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|
| SBR | 390,696 | 405,155 | 378,305 | 368,192 |
| SBR latex | 267,855 | 251,388 | 235,689 | 244,918 |
| Nitrile | 68,509 | 70,105 | 59,784 | 64,225 |
| Butadiene | 270,726 | 287,705 | 271,953 | 298,216 |
| Polychloroprene | 91,074 | 76,625 | 80,360 | 83,470 |
| Ethylene-Propylene | 136,056 | 145,601 | 145,583 | 157,211 |
| All other | 152,374 | 151,437 | 138,118 | 132,726 |
| Total | 1,377,290 | 1,388,016 | 1,309,792 | 1,348,958 |

Source: The Chemical Daily Co., *Japan Chemical Annual, 1995*, Tokyo, Japan, pp. 53-55.

# APPENDIX A
# EXPLANATION OF TARIFF AND TRADE AGREEMENT TERMS

# APPENDIX A
# TARIFF AND TRADE AGREEMENT TERMS

In the ***Harmonized Tariff Schedule of the United States*** (HTS), chapters 1 through 97 cover all goods in trade and incorporate in the tariff nomenclature the internationally adopted Harmonized Commodity Description and Coding System through the 6-digit level of product description. Subordinate 8-digit product subdivisions, either enacted by Congress or proclaimed by the President, allow more narrowly applicable duty rates; 10-digit administrative statistical reporting numbers provide data of national interest. Chapters 98 and 99 contain special U.S. classifications and temporary rate provisions, respectively. The HTS replaced the ***Tariff Schedules of the United States*** (TSUS) effective January 1, 1989.

Duty rates in the ***general*** subcolumn of HTS column 1 are most-favored-nation (MFN) rates, many of which have been eliminated or are being reduced as concessions resulting from the Uruguay Round of Multilateral Trade Negotiations. Column 1-general duty rates apply to all countries except those enumerated in HTS general note 3(b) (Afghanistan, Cuba, Laos, North Korea, and Vietnam), which are subject to the statutory rates set forth in ***column 2***. Specified goods from designated MFN-eligible countries may be eligible for reduced rates of duty or for duty-free entry under one or more preferential tariff programs. Such tariff treatment is set forth in the ***special*** subcolumn of HTS rate of duty column 1 or in the general notes. If eligibility for special tariff rates is not claimed or established, goods are dutiable at column 1-general rates. The HTS does not enumerate those countries as to which a total or partial embargo has been declared.

The ***Generalized System of Preferences*** (GSP) affords nonreciprocal tariff preferences to developing countries to aid their economic development and to diversify and expand their production and exports. The U.S. GSP, enacted in title V of the Trade Act of 1974 for 10 years and extended several times thereafter, applied to merchandise imported on or after January 1, 1976 and before the close of May 31, 1997. Indicated by the symbol "A" or "A*" in the special subcolumn, the GSP provided duty-free entry to eligible articles the product of and imported directly from designated beneficiary developing countries, as set forth in general note 4 to the HTS.

The ***Caribbean Basin Economic Recovery Act*** (CBERA) affords nonreciprocal tariff preferences to developing countries in the Caribbean Basin area to aid their economic development and to diversify and expand their production and exports. The CBERA, enacted in title II of Public Law 98-67, implemented by Presidential Proclamation 5133 of November 30, 1983, and amended by the Customs and Trade Act of 1990, applies to merchandise entered, or withdrawn from warehouse for consumption, on or after January 1, 1984. Indicated by the symbol "E" or "E*" in the special subcolumn, the CBERA provides duty-free entry to eligible articles, and reduced-duty treatment to certain other articles, which are the product of and imported directly from designated countries, as set forth in general note 7 to the HTS.

Free rates of duty in the special subcolumn followed by the symbol "IL" are applicable to products of Israel under the ***United States-Israel Free Trade Area Implementation Act*** of 1985 (IFTA), as provided in general note 8 to the HTS.

Preferential nonreciprocal duty-free or reduced-duty treatment in the special subcolumn followed by the symbol "J" or "J*" in parentheses is afforded to eligible articles the product of designated beneficiary countries under the ***Andean Trade Preference Act*** (ATPA), enacted as title II of Public Law 102-182 and implemented by Presidential Proclamation 6455 of July 2, 1992 (effective July 22, 1992), as set forth in general note 11 to the HTS.

Preferential or free rates of duty in the special subcolumn followed by the symbol "CA" are applicable to eligible goods of Canada, and rates followed by the symbol "MX" are applicable to eligible goods of Mexico, under the ***North American Free Trade Agreement***, as provided in general note 12 to the HTS and implemented effective January 1, 1994 by Presidential Proclamation 6641 of December 15, 1993. Goods must originate in the NAFTA region under rules set forth in general note 12(t) and meet other requirements of the note and applicable regulations.

Other special tariff treatment applies to particular ***products of insular possessions*** (general note 3(a)(iv)), products of the West Bank and Gaza Strip (general note 3(a)(v), goods covered by the ***Automotive Products Trade Act*** (APTA) (general note 5) and the ***Agreement on Trade in Civil Aircraft*** (ATCA) (general note 6), ***articles imported from freely associated states*** (general note 10), ***pharmaceutical products*** (general note 13), and ***intermediate chemicals for dyes*** (general note 14).

The ***General Agreement on Tariffs and Trade 1994*** (GATT 1994), annexed to the Agreement Establishing the World Trade Organization, replaces an earlier agreement (the GATT 1947 [61 Stat. (pt. 5) A58; 8 UST (pt. 2) 1786]) as the primary multilateral system of disciplines and principles governing international trade. Signatories' obligations under both the 1994 and 1947 agreements focus upon most-favored-nation treatment, the maintenance of scheduled concession rates of duty, and national (nondiscriminatory) treatment for imported products; the GATT also provides the legal framework for customs valuation standards, "escape clause" (emergency) actions, antidumping and countervailing duties, dispute settlement, and other measures. The results of the Uruguay Round of multilateral tariff negotiations are set forth by way of separate schedules of concessions for each participating contracting party, with the U.S. schedule designated as Schedule XX.

Pursuant to the ***Agreement on Textiles and Clothing*** (ATC) of the GATT 1994, member countries are phasing out restrictions on imports under the prior "Arrangement Regarding International Trade in Textiles" (known as the **Multifiber Arrangement** (MFA)). Under the MFA, which was a departure from GATT 1947 provisions, importing and exporting countries negotiated bilateral agreements limiting textile and apparel shipments, and importing countries could take unilateral action in the absence or violation of an agreement. Quantitative limits had been established on imported textiles and apparel of cotton, other vegetable fibers, wool, man-made fibers or silk blends in an effort to prevent or limit market disruption in the importing countries. The ATC establishes notification and safeguard procedures, along with other rules

concerning the customs treatment of textile and apparel shipments, and calls for the eventual complete integration of this sector into the GATT 1994 over a ten-year period, or by Jan. 1, 2005.

# APPENDIX B
# GLOSSARY OF INDUSTRY TERMS

# GLOSSARY OF INDUSTRY TERMS

**Activators**
Compounding material used in small proportions to increase the effectiveness of an accelerator.

**Antioxidants**
Compounding material used to retard deterioration caused by oxidation.

**Calendering**
Use of a precision machine equipped with three (or more) heady, internally heated or cooled rolls, or both, revolving in opposite directions, which is used for continuously sheeting or plying up rubber compounds, and frictioning or coating fabric with rubber compounds.

**Copolymer**
A polymer formed from two or more types of monomers.

**Cross-linking**
The union of two large molecules by means of an atom or a small molecule with two active portions. Sulfur atoms may crosslink rubber molecules during vulcanization.

**Diene polymers**
Polymers prepared from diolefins with conjugated double bonds, for example, 1,3-butadiene, isoprene (2-methyl-1,3-butadiene), and 2,3-dimethyl-1,3-butadiene.

**Elastomer**
Refers to natural and synthetic vulcanizable products which possess elastic properties after crosslinking (vulcanization), and can be stretched to at least twice their original length (at room temperature) and after removal of the tension will return to their original length. Although the term elastomer has been extended to thermoplastic (uncrosslinked) polymers, this report does not include thermoplastic elastomers.

**Extrusion**
The process of forming continuous shapes by forcing a molten material through a die.

**Fillers**
A relatively inert substance added to plastic/rubber compounds to reduce their cost and/or to improve physical properties, particularly hardness, stiffness, and impact strength.

**Isomers**
The existence of different spatial or geometrical configurations of a particular chemical compound.

**Latex**
An aqueous colloidal emulsion of rubber or certain plastics. It generally refers to the emulsion obtained from a tree or plant or produced by emulsion polymerization.

**Monomer**

A relatively simple compound, usually containing carbon and of low molecular weight, that can react to form a polymer by combination with itself or with other similar molecules or compounds.

**Natural rubber**

The basic polymer referred to as natural rubber is known chemically as cis-1,4-polyisoprene. However, during the biosynthesis of rubber in the plant, proteins, carbohydrates, resins, mineral salts, fatty acids, and other impurities are also produced. There are reportedly over 200 species of plants from which natural rubber can be obtained, but *Hevea brasiliensis* (Hevea) accounts for more than 99 percent of world production of natural rubber.

**Plasticizer**

A substance or material incorporated in a material to increase its flexibility, workability, or distensibility.

**Polymer**

A macromolecular material formed by a polymerization reaction.

**Vulcanization**

Refers to the conversion of rubber from a predominantly soft, plastic-like material into a strong elastic (rubbery) material. This is accomplished by forming three-dimensional cross-linking between the single molecules to obtain a continuous network of flexible elastic chains. Vulcanization usually requires sulfur or heat, in a traditional vulcanizing method, or alternatively with certain chemicals, such as organic peroxides.

Sources: K.F. Heinisch, *Dictionary of Rubber; Hawley's Condensed Chemical Dictionary*; and *Whittington's Dictionary of Plastics.*