

# Titanium

*Joseph Gambogi, the titanium commodity specialist for the U.S. Geological Survey, has compiled the following information on titanium, the ninth most abundant element in Earth's crust.*

From paint to airplanes, titanium is important in a number of applications. Commercial production comes from titanium-bearing ilmenite, rutile and leucoxene (altered ilmenite). These minerals are used to produce titanium dioxide pigment, as well as an assortment of metal and chemical products.

Globally, about 95 percent of titanium mineral production is used to produce titanium dioxide pigment. The refractive index and resulting light-scattering ability of titanium dioxide pigment produce excellent opacity and brightness. Consequently, titanium dioxide pigment is important in the production of coatings (including paint, varnish and lacquer), as well as in the paper and plastic industries. The pigment is also used in catalysts, ceramics, textiles, rubber, floor coverings, printing ink and roofing tiles.

Aside from titanium dioxide production, other titanium compounds play an important role in many industrial processes. For example, titanium trichloride is used as a catalyst for polypropylene polymerization. Barium titanate and strontium titanate are used in electronic components, whereas potassium hexafluorotitanate is used in production of titanium aluminum master alloys. Titanium nitrides and carbides are used to form corrosion- and wear-resistant coatings.

The major use for titanium metal is in commercial and military aerospace components. Other purposes of titanium metal include automotive exhausts, bicycle frames, golf clubs, heat exchangers, military armor, medical implants, sporting goods and submarine hulls. Historically, fluctuations in the aerospace industry have resulted in cyclic demand for titanium metal. In 2002, global production of primary metal was about 72,000 tons, whereas domestic consumption was 17,300 tons. Research and development programs, such as the Defense Advanced Research Projects Agency's Titanium Initiative, may lower the cost of titanium metal production.

The steel and nonferrous alloy industries also consume titanium metal. In steelmaking, titanium is used for deoxidation, grain-size control, carbon and nitrogen control, and stabilization. When used in aluminum alloys, titanium improves casting and reduces cracking. In 2002, the estimated use of titanium by these industries was 8,000 metric tons.

World production of titanium-bearing minerals in 2002 was about 4.7 million metric tons of contained titanium dioxide. Domestic consumption was about 1.4 million metric tons. Major sources of titanium minerals included Australia, Canada, India, Norway, South Africa and Ukraine.

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Sample of the mineral titanium with penny for scale. Image from *Minerals in Your World*.