

The metal of the gods makes things lighter

Titanium was long considered an exotic material. But today it can be found wherever low weight has to coincide with maximum hardness and corrosion-resistance – for example in aircraft construction

By Lukas Weber | Illustrations Peter Krämer

The name really was not well chosen. Cronos, the youngest of the titans, was a clumsy lad who castrated his hated father, Uranus, and became master of the universe. He stomped around heavily for a while until he was finally overthrown by his son Zeus after a 10-year battle. Today's titanium takes its name from the titans of legend but comes across as light-footed in comparison to its mythological namesake. It is a high-tech material whose future lies ahead of it. That is because titanium is on its way to becoming the master of the universe among metals.

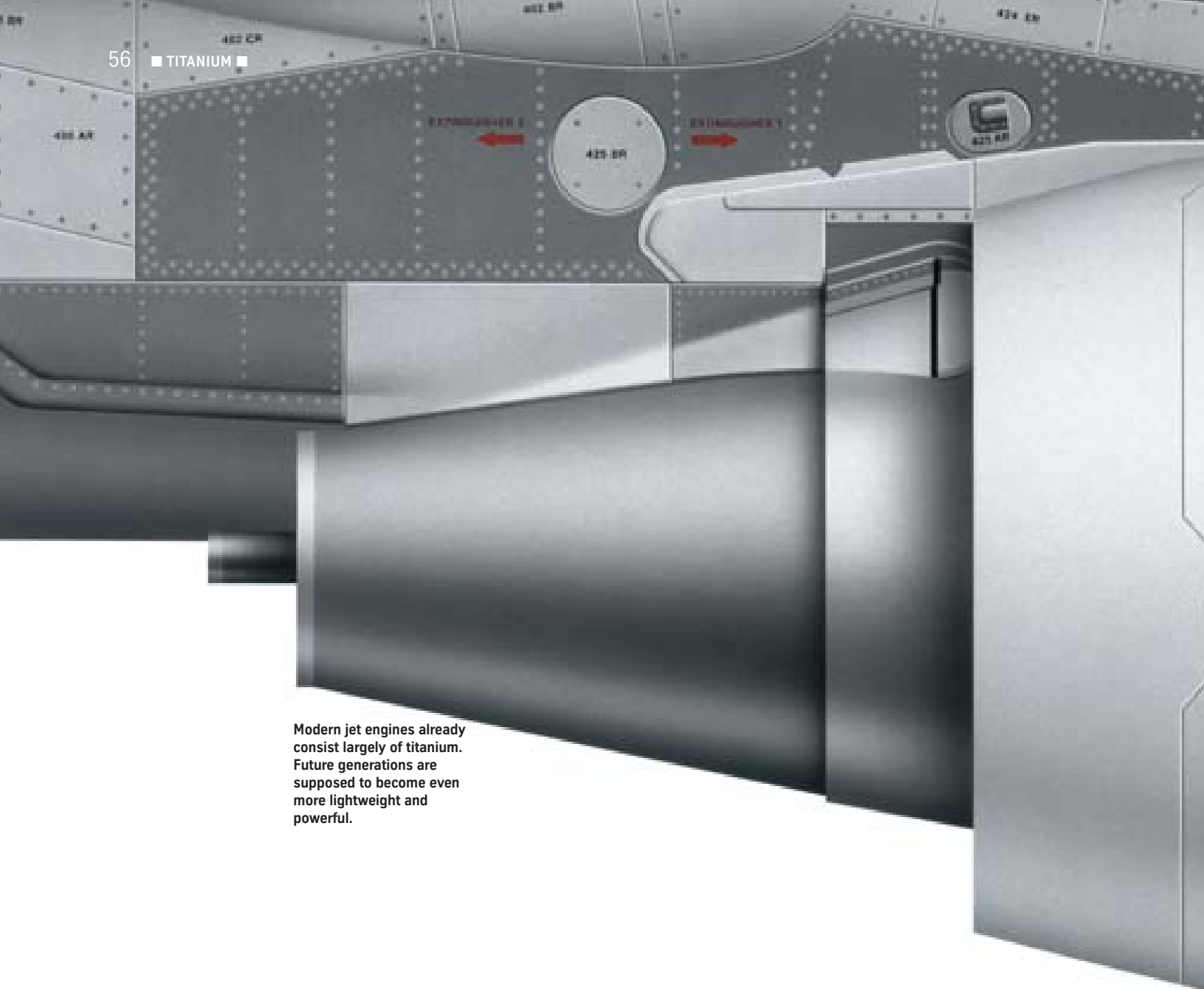
History does not tell us what motivated the German chemist Martin H. Klaproth to turn to Greek mythology when looking for a name for the metal oxide he first isolated from the mineral rutile in 1795. Klaproth could not have guessed at the modern uses of titanium. While titanium is among the 10 most common elements and titanium dioxide is inexpensive to produce – it shines out from nearly every white paint: In cars, building facades, even in the white powder on top of salamis – the pure form of the metal is extremely difficult to make. It was not until the middle of the past century that it could be commercially produced.

A RANGE OF REMARKABLE PROPERTIES

But it was worth the wait. The list of advantages offered by the chemical element with the symbol Ti as a pure metal just goes on and on. Titanium has the strength of the best steels but weighs only half as much. It does not corrode, not even in most acids or lyes. Titanium is elastic and tough, hardly expands in rising temperatures and can withstand cold without becoming brittle. And important for processing: It can be rolled, forged and welded.

No wonder that the whole world is calling for this super metal. "Every two or three years, a new industrial sector is added," says





Modern jet engines already consist largely of titanium. Future generations are supposed to become even more lightweight and powerful.

Higher, faster, farther

Helmut M. Jost, sales head at Deutsche Titan (German Titanium) in Essen, a subsidiary of ThyssenKrupp Stainless GmbH. They produce 300 tons a month of the popular metal in the form of semi-finished goods for other producers. “The market is growing rapidly,” explains Jost. Deutsche Titan, established in 1988 as one of the first joint ventures between Thyssen and Krupp, is working at the limit of its capacity.

GOOD AND EXPENSIVE

Aren't there any disadvantages then? “Sure,” says Jost dryly, “the price.” A kilogram of pure titanium sheet metal costs around 20 dollars. That is about seven or eight times more expensive than stainless steel and four times as expensive in terms of half specific weight. As a result, it is used mainly as a replacement for steel and aluminum where either



price plays virtually no role or the desired characteristics outweigh the cost disadvantage.

In medicine, for example. Titanium has been the material of choice for artificial hips and teeth implants for over 30 years because the human body can tolerate it like no other material. However, the real pioneers were the world's military forces, for whom the astonishing characteristics of the tough metal were probably just what they had been looking for for a wide variety of uses. Security technology is one of the areas that benefited from the military research. Today titanium can be found in armored cars, bullet-proof vests, and the protective helmets of the elite German GSG 9 commandos.

The fact that titanium is both light and strong is what makes it especially appealing to aircraft manufacturers. One of the most interesting developments was the SR-71 "Blackbird" reconnaissance aircraft

from Lockheed. As early as the beginning of the 1960s, the outer skin of this aircraft was made mainly from titanium. With its ability to fly 30 kilometers high and reach speeds reportedly in excess of 3,500 kilometers an hour, the SR-71 set record after record.

START OF SERIAL PRODUCTION

Today, the extensive use of titanium in aircraft in large-scale production is also common. This has caused global demand to rise. Nearly 3,000 military aircraft are planned around the globe for the next few years, one-third of them in Europe. Each Eurofighter will contain seven tons of titanium, while the American C-17A transport plane from Boeing has as much as 68 tons.

Weight is also a critical factor in commercial aircraft. Every kilogram shaved in construction is another kilogram of cargo or passen-

gers that can be flown. That is why Deutsche Titan products have flown with civilian air and spacecraft for three decades now. They can be found in the European Ariane rocket, television satellites and space laboratories, and especially in Airbus aircraft. The new Airbus A380 jumbo jet, which will enter service in 2006, is supposed to have a maximum takeoff weight of 560 tons - a goal that can only be reached if steel is widely replaced by titanium. Around 75 tons will be used. The older but smaller Airbus A340 contains only 22 tons of titanium. The trend has been similar at Airbus's competitor Boeing. Boeing's popular 777 model from the year 1990 uses 58 tons of titanium. The new 7E7, which is supposed to enter service in 2007, contains 10 tons less, but titanium makes up a higher percentage than steel and represents 15 percent of the total weight. Experts have no doubt that the use of titanium will continue to grow while that of steel and aluminum falls. However, the aluminum outer skin will probably not be replaced by titanium in the future. "Too expensive and not necessary," says Airbus Industries.

The list of parts made out of titanium alloys is long. In addition to engine components and their suspensions, there are hydraulic lines, door fittings, rivets, and screws. Soon, passengers will have the strong

metal directly under them too. Lufthansa is installing new recliner seats in its Airbus 340-600 fleet. Thanks to the generous use of titanium, the Lufthansa-built seats are expected to be 20 percent lighter than comparable seats in competitors' aircraft. Other typical uses include forged landing gear parts, wing leading edges, fire bulkheads and parts of the brake system. For every use, there is an alloy which makes the characteristics of titanium, such as strength or resistance to corrosion, even better. "The workhorse of our high-quality alloys consists of 90 percent titanium with 6 percent aluminum and 4 percent vanadium," explains Jost. Other ingredients include molybdenum, zirconium and palladium.

ADDITIONAL APPLICATIONS IN THE OFFING

Unalloyed titanium is produced in all semi-finished forms. From open die forging parts to thin sheets, from which, for example, ventilation pipes for aircraft or cooling pipes for nuclear power plants are made. Thirty different types are produced in Essen, using different qualities of the raw material, called titanium sponge. The precise amount to the gram of additives is mixed in automatically, before being pressed under 2,500 tons of pressure into a block and then welded to the electrode

Harder, lighter, tougher



and melted in a high vacuum oven. While the importance of titanium for the aerospace industry has increased, the importance of the aerospace industry has decreased for titanium. After the shock of September 11, 2001, the aerospace industry went into a tailspin that it is just now starting to come out of. Annual global consumption of titanium, which reached 60,000 tons in 1997, melted as a result. This year it will likely bounce back to 50,000 tons. Deutsche Titan has ended its former dependence on the aerospace industry. Now just barely a quarter of its sales come from this sector.

There are enough applications for titanium. For example, in buildings. The steel bridge piles of the Trans-Tokyo Bay Highway received an insoluble metal plating attached to the steel, the same is true for the first floating airport on Tokyo bay. The Guggenheim Museum in Bilbao, Spain, is clad in a titanium cover. On oil drilling platforms it is used for pipelines, heat exchangers, and rising pipes. Sports equipment makers have long appreciated titanium alloys for making golf clubs, bicycle frames or yacht equipment, and they are the perfect material for spikes. The human body's high tolerance of titanium makes it not only useful for medicine but also for the watch and jewelry industry.

Desalination plants will become very important in the near future. Large ones cannot do without titanium and water consumption in the Arabian and southern Mediterranean regions is growing exponentially. The automobile industry, which is highly interested in saving weight, is also waiting in the wings. However, up until now it has limited its use of titanium to small parts which have to withstand high pressure.

NOBLE RACE CARS MADE OF NOBLE MATERIALS

So far, only very expensive, exotic car makers such as Bugatti or Ferrari have made extensive use of titanium. Rumor has it that Formula 1 racing cars from Maranello contain more titanium than any of their competitors' cars have in their rear-view mirrors. And now, the divine origin of the element's name has finally found modern day confirmation: The valuable head of race car titan Michael Schumacher is protected by a one-piece helmet costing 12,000 euros, designed and produced by the Schubert helmet factory in Braunschweig, Germany. The helmet is made out of a carbon fiber-kevlar combination stiffened by titanium loops. It is so strong that the helmet of the German auto racing titan could even survive being rolled over by a tank. ◀

**High-strength materials needed:
Lighter blades sit on thinner
shafts – the weight reduction
continues.**

