A number of disruptive technologies are focused on elevating titanium’s status to a commodity metal. In the future, widely available and cheap titanium could provide developing countries with affordable water desalination metal, prostheses to help cope with an ageing population.

With environmental legislation increasingly emphasising a reduction in carbon emissions, there is a growing need to reduce weight. Both the defence and automotive sectors could therefore benefit from a source of low cost titanium, primarily to replace steel in a wide variety of components. Initially, this would be on rapid deployment equipment, lightweight tanks and armour, and heavy-duty vehicles, such as buses and tractors, as well as in axles, drive shafts, suspensions and exhaust systems. The next market would be mass-produced family vehicles – the ‘holy grail’ for the titanium industry.

**Down with the costs**

Today, the major drawback of titanium is its high cost. The price of a mill product is in excess of £25/kg (mild steel is £5/kg). This is principally due to titanium’s strong affinity for oxygen, which creates challenges both during extraction and downstream processing.

The dominant extraction process at present is a metallothermic reduction method, developed by Wilhelm Kroll 60 years ago. Although it is a slow batch technique, it accounts for less than 40% of the final mill product cost. Downstream processing of the titanium sponge Kroll product, which involves double or triple vacuum arc remelting (VAR) to ingot prior to thermomechanical processing, has the largest bearing. Hence, a low cost extraction alternative to the Kroll process alone is insufficient to provide a substantial economic step change. If the transition metal is ever to break into the family car market, the key lies with improving the downstream, powder-to-product technologies.

**Movers and shakers**

To meet the increasing demand of the cyclical aerospace sector, and perhaps to invest in a lucrative stockpile, titanium producers have started to scale-up (or bring back online) their sponge and melting capabilities. China intends...
to increase its annual sponge capacity from 15,000 to 120,000t by 2010. With the current annual global production capacity at only 130,000t, China is set to have a major influence on the titanium market. To put this into perspective, the steel industry produces such volumes every hour.

Over the next decade or so, the majority of titanium production capacity will be required to manufacture aircraft and turbine engine components (with the remainder supplying the chemical process industries). This is because the next generation of fuel-efficient civil airliners, such as the Boeing 787 Dreamliner and Airbus A350-XWB (see main image), will consist of a carbon fibre composite fuselage and wings. Up to 20% (by weight) of titanium will be employed as fasteners and couplings, due to the material’s superior galvanic corrosion resistance, compared to aluminium and steel, when in contact with graphite.

In fact, Airbus, Boeing and Rolls-Royce plc have negotiated long-term supply agreements with titanium producers in the USA, such as the Titanium Metals Corp (TIMET), and VSMPO-AVISMA Corp (currently the largest producer). Non-aerospace and emerging markets may suffer from this increased titanium usage in the skies. Encouragingly, many of these potential market sectors, such as defence and automotive, will not require the grades or purities specified by the aerospace industry and the associated high prices.

Stepping up
Over the last few years there has been an increased worldwide effort to provide a step change in the economics of the supermetal. This was ignited in the UK in the late 1990s by Derek Fray, Tom Farthing and George Zheng Chen at the University of Cambridge, who discovered an electrochemical reduction process to extract oxygen from TiO₂ to produce low oxygen titanium metal (the FFC Cambridge process).

Such a potentially useful technology inspired the US Defense Advanced Research Projects Agency (DARPA) to fund research in the UK into understanding and developing the process further. A positive outcome is the ease with which the high strength – beta (body centred cubic allotrope) alloys are produced. Scientists at Imperial College London, UK, exploited the process to produce a Ti-10W alloy (see image, above) that has possible biomedical applications. The alloy choice was audacious because tungsten is...
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