Scandium

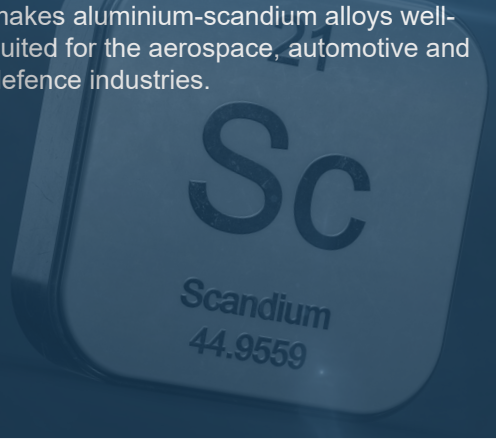
The Path to Innovative Solutions and Sustainable Technologies

WHAT IS SCANDIUM

- Scandium (Sc) is a lightweight, soft metal with a high melting point and good electrical and heat conductivity.
- Combined with aluminium (Al), at approximately 0.25wt% Sc, it creates stronger, lightweight, and corrosion-resistant scandium – aluminium (Sc-Al) alloys for aerospace, aviation, defence, automotive and energy transmission applications.
- Scandium is not particularly rare – its occurrence in crustal rocks is around 22 parts per million (ppm). It is generally more plentiful than lead, mercury, and precious metals – yet scandium rarely concentrates in nature, so occurrences with over 100ppm in the earth's crust are rare.
- As a result, scandium has been produced exclusively as a byproduct during processing of various ores or recovered from previously processed tailings or residues (USGS 2024).
- It is estimated that only 30-40 metric tons of scandium were supplied and consumed in 2023 (USGS, 2024) although Sverdrup (2023) make the point that current scandium use is dominated by military applications causing numbers to be kept secret, which makes it difficult to get an accurate estimate of real consumption.
- Scandium is on the Critical Minerals List for Australia, Canada, the European Union and the United States.
- The United States and its allies are dependent on imports of scandium with the primary sources being China, Kazakhstan, Philippines, Russia and Ukraine (USGS 2022, 2024 and NioCorp website) and as such rising demand for scandium is supply constrained due to geopolitical risk associated with countries like China and Russia.

WHAT IS SCANDIUM USED FOR

- Scandium when used in combination with aluminium can produce stronger, more corrosion resistant, heat tolerant, weldable and 3D printable aluminium products.
- Sc-Al alloy powders offer the potential for 3D printing of complex metal structures that are difficult or expensive to produce using traditional fabrication methods.
- Scandium also exhibits exceptional electrical conductivity and heat stabilisation qualities, and the largest volume currently in use is in solid oxide fuel cells.
- In industrial applications, scandium acts as a grain refiner and hardener of aluminium alloys.
- The combination of all these properties makes aluminium-scandium alloys well-suited for the aerospace, automotive and defence industries.



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INDUSTRIES LIKELY TO USE THE BULK OF SCANDIUM WITH GUARANTEED SUPPLY

Rimfire believes that Western Governments and advanced manufacturers are looking to secure long-term supplies of scandium from favourable jurisdictions like Australia before committing to the greater use of scandium-alloyed aluminium materials in their products.

Rimfire's Fifield and Avondale Projects are ideally positioned to take advantage of the growing demand for scandium and offer significant opportunities both in terms of deposit size and grade.

Assuming a long-term guaranteed supply of scandium becomes available from a stable geo-political environment, several industries are potential high-volume users:

AREOSPACE

Aircraft manufacturers: Scandium-aluminium alloys offer significant weight reduction (potentially up to 15% to 20%) and improved strength which make them ideal for fabrication of fuselage structures, wings and engine components. Its use would translate to lighter, more fuel-efficient aircraft with reduced emissions and increased range. Sc-Al alloys are also being used in 3D printing of parts which, apart from the obvious inventory efficiencies, can extend the life of older aircraft which otherwise would be permanently grounded due to the unavailability of traditionally manufactured parts. 3D printing of aircraft parts has the potential to be a very high-volume application for Sc-Al alloys.

Spacecraft and rocket components: Scandium offers high strength-to-weight ratio and high melting points, ideal for lightweight, high-performance components in spacecraft and rockets. Relativity Space, a United States privately - owned rocket building company, uses Sc-Al alloys for 3D printing of rockets for commercial orbital launch services. Visit the company's website to see a rocket being 3D printed (www.relativityspace.com/factory).

DEFENCE

Aircraft manufacturers and spacecraft and rocket components: Same as for Aerospace above but with a military application.

Military Equipment: Scandium alloys are used in military equipment and armour plating due to its strength and durability. These alloys help reduce the weight of military vehicles and equipment while maintaining structural integrity.

Navy: Scandium alloys are being used to 3D print replacement parts for ships, both existing and under construction.

TRANSPORTATION

Automotive: Scandium alloys could be used in high-performance vehicles, electric vehicles, and luxury cars for weight reduction and improved fuel efficiency or driving range.

Rail and marine sectors: Scandium could be used in high-performance train components and lightweight, durable ship structures.

ENERGY

Solid oxide fuel cells (SOFCs): A principal use for Scandium is in SOFCs and the demand for SOFCs is anticipated to grow significantly as the demand for cleaner more efficient energy grows. Scandium stabilizes zirconia electrolytes in SOFCs, improving efficiency, durability, and operating temperature. This could contribute to wider adoption of cleaner and more efficient energy generation.

Nuclear energy: Scandium alloys have potential for use in advanced nuclear reactors due to their high strength at high temperatures and radiation resistance.

ELECTRONICS AND LIGHTING

Semiconductors: Scandium-doped gallium nitride (GaN) semiconductors show promise for high-power and high-frequency electronic devices used in 5G and future communication technologies.

LED lighting: Scandium-based phosphors could improve the efficiency and colour quality of LEDs.

OTHER POTENTIAL APPLICATIONS

Sports and recreation: Scandium alloys could be used in high-performance bicycles, golf clubs, and other sporting goods for strength and weight reduction.

Medical devices: Scandium alloys could be used in orthopaedic implants and surgical instruments due to their biocompatibility and strength.

THE MARKET OUTLOOK FOR SCANDIUM

- Currently, most of the global scandium market is supplied by China, Kazakhstan, Philippines, Russia, and Ukraine, according to U.S. Geological Survey estimates. Narayanan et al (2018) estimate scandium demand will increase to 3000 t/annum by 2032.
- Before committing to use scandium-alloyed aluminium materials, Rimfire believes that aircraft and defence manufacturers will require a commercially viable large scale long life primary production source from a stable geo-political environment at quantities many times the current annual global production.
- By way of example, Phoung et al (2023), suggested that automobile scandium use alone could increase to 5300 tonnes by 2030 through the increased use of aluminium-scandium alloys.
- The demand for scandium is all about supply. Rimfire and the broader industry believe that demand is currently supply constrained which highlighted by Rio's establishment of a dedicated Scandium division (Element North21 website).

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