RIO TINTO
ALUMINIUM

SMELTING ALUMINIUM

How is aluminium made?

The third and final step in the production of aluminium is the smelting of alumina into aluminium metal. Two tonnes of alumina are needed to produce one tonne of aluminium metal.

Alumina is made up of aluminium and oxygen. To produce aluminium metal, it is necessary to separate these two elements. The process that transforms alumina into aluminium is called *smelting* and was invented in 1886 by Charles Hall in America and Paul Heroult in France. As Hall and Heroult made their discoveries independently at around the same time, the process is known as the *Hall-Heroult Process*.

Smelting takes place in large, steel, carbon-lined furnaces known as *reduction cells*. The carbon lining is called a *cathode*. Alumina is fed into the cells where it is dissolved in molten cryolite, a liquid which can dissolve alumina and conduct electricity at around 970°C.

Electricity is introduced into each cell through carbon blocks manufactured by smelters, called anodes. The anodes are made in a three-step process:

1. Forming
Petroleum coke and recycled carbon from used anodes are mixed with liquid pitch. This mixture is heated to 160°C until it forms a hot paste. It is then cooled to 115°C and hydraulically pressed or vibrated in a mould to form an anode block.

2. Baking
The carbon anodes are transferred by conveyor to the carbon baking furnace, where they are baked at temperatures of up to 1,150°C in a pre-heating, firing and cooling cycle which takes 18 to 20 days. This further heating helps rid the anodes of impurities and improves their strength and electricity conducting ability.

3. Rodding
In the rodding room, the carbon anode is bonded to a metal rod using molten cast iron. This rod allows the anode to be suspended from the reduction cell superstructure during the smelting process. A carbon anode usually lasts a few weeks. After this time, the used anode is recycled in the anode forming process.

Reduction
All of the reduction cells are connected in series by aluminium busbar which carries an electric current and these cells form a reduction line. A continuous electric current of 100,000 to 320,000 amps (depending on the smelter) flows from the anode, through the alumina/cryolite mixture, to the carbon cathode cell lining, and then to the anodes of the next cell, and so on. The electric current enables alumina to react with the carbon anode to form aluminium and carbon dioxide. Between 13,000 and 15,000 kilowatt-hours of electricity are used to make one tonne of aluminium. The oxygen combines with the carbon to form carbon dioxide at the top of the cell. The reduction cell offgasses are cleaned to remove contaminants and released into the atmosphere.

The aluminium, in a molten form, sinks to the bottom of the cell. It is siphoned out in a process known as *tapping* and is transported to a holding furnace to be cast into products. The metal may be cast as pure aluminium (better than 99.7%) or small amounts of other elements, such as magnesium, silicon or manganese, are added to form aluminium alloys. Different alloys give different properties to the metal, such as extra strength or greater resistance to corrosion.

RIO TINTO
ALUMINIUM

Casting
The molten aluminium is cast at a temperature of just over 700°C to form ingots, large blocks, t-bar or long cylindrical logs called *extrusion billet*. Special ingot casting machines cast, stack, strap and weigh ingots automatically into one tonne bundles ready for transport. Extrusion billet and t-bar are cast to specific customer requirements using a process known as *vertical direct chill casting*. In these forms the metal is known as *primary aluminium*.

Rio Tinto Aluminium's primary aluminium is produced at four smelters - Boyne Island in Queensland, Bell Bay in Tasmania, Tiwai Point in New Zealand and Anglesey in the United Kingdom.

Manufacturing

Primary aluminium can be rolled, extruded or cast to make aluminium end-products. Extruding is a process in which round logs (billet) of hot aluminium are forced though a pattern cut into a steel die. Casting occurs when molten aluminium is poured into moulds to manufacture specific shapes.

What is aluminium used for?

Aluminium is widely used in the transport, construction, packaging and electrical industries. In the transport sector aluminium is used in cars (engine blocks, cylinder heads, transmission housings and body panels); in trucks and buses (sheet and plate for bodies); in railway stock and in aircraft. In the construction sector aluminium is used in sheet products for roofing and wall cladding, in extrusions for windows and doors and in castings for builders' hardware. In the packaging sector aluminium is used in the form of alloy sheet for beverage can bodies and tops; as foil for household and commercial wrap and in manufactured packaging products such as cartons for fruit juice and packaging for pharmaceuticals. In the electrical sector aluminium is used in the form of wire, normally reinforced with steel to form cables.

The economic and environmental benefits of aluminium

Aluminium is a metal which can be easily and economically recycled, by melting it down and casting new products.

Recycled aluminium is known as *secondary aluminium*. Recycling aluminium uses only five per cent of the energy needed to produce the primary metal from bauxite. Any aluminium product can be recycled; the metal can be melted again and again without losing any of its properties. One of the most important sources of secondary aluminium is aluminium cans. Australia is a world-leader in this area, recycling over 60 per cent of all cans used.

Aluminium is light, strong and pliable. When compared with most other metals, less energy is required to manufacture products from aluminium and to transport them, resulting in significant energy cost savings for industry.

Using aluminium to build cars reduces fuel consumption and greenhouse gas emissions. In Australia, 86 per cent of greenhouse gas emissions from the transport sector are from road transport.