Introduction

Rolling aluminium and its alloys is one of the principle ways of converting cast aluminium slab from the smelters and wrought re-melts into a usable industrial form. By hot rolling, it is possible to reduce a slab of about 600mm thickness down to plate material with thicknesses of 6 - 250 mm and further down as low as 2mm for subsequent cold rolling to sheet with thicknesses as low as 0.2mm. Further rolling can produce the thinnest of foil with a thickness as low as 0.006 mm, approximately one-third the thickness of a human hair!

Common to all rolled aluminium products are the properties of lightness, strength and durability. These three, coupled with other specific properties for particular applications, make rolled aluminium one of the most versatile materials available for the major markets of packaging, transport, and building and construction.

The use of aluminium in place of heavier alternative materials enables significant energy savings to be made over the product's life cycle, for example in transportation and in all areas where products move or are carried.

Metal recovery is another important characteristic, aluminium is easily recycled after use and similar rolled products to those recycled can be produced using only 5% of the energy required to make the initial primary metal. Thus aluminium roofing sheet can be recycled into more roofing sheet and an aluminium beverage can recycled into another aluminium beverage can.

The Process

Conventional Rolling

The starting material for rolled products is rectangular cast slabs weighing up to 30 tonnes each. These slabs are heated to a temperature of around 525°C and then passed repeatedly through a hot rolling mill until either the required plate thickness is obtained or until the metal is thin enough (generally about 3 mm thick), to be coiled ready for cold rolling – the last 3 or 4 hot rolling passes are usually performed sequentially through a 3 or 4 stand “tandem” mill. From this stage onwards, right down to the thinnest of foil thicknesses, the metal is fed in coil form through a series of single or multi-stand cold rolling mills which successively reduce the metal thickness and recoil it after each rolling pass, ready for the next, until the required thickness is obtained. Annealing may be required between passes depending on the final temper (hardness) required.

The rolling of cast aluminium changes its metallic structure and the metal takes on new characteristics and properties. The brittleness of the coarse, as-cast structure is replaced by a stronger and more ductile material, with the degrees of strength and ductility being variable factors that are functions of the amount of rolling (deformation) given to the metal, the rolling temperature, the alloy composition and the use of annealing.

Commercial purity aluminium obtained from the smelting operation has a composition of between 99% and 99.7% aluminium with the remainder made up of other constituents such as iron and silicon.

Such metal when rolled is relatively soft and ductile. However by adding controlled quantities of other elements such as manganese, magnesium, zinc, copper and silicon to a melt of commercially pure aluminium, it is possible to prepare alloys that have a wide range of different properties and strength characteristics. Many alloys have been formulated specifically for rolling to plate, sheet and foil.

Also, by special refining of the metal during the smelting operation, it is possible to obtain aluminium having a purity of up to 99.99% which can be used for special products such as reflector sheet and in electrical applications.
Strip Casting
These are special processes which eliminate the need for hot rolling and its' associated high capital costs.

Twin-roll casting (TRC)
Molten metal is fed into a converging cavity set by two internally cooled, counter-rotating rolls. The process relies on the heat transfer between the solidifying (& compressed) melt and the roll surfaces to solidify the aluminium which results in very high cooling rates. Because of this, conventional twin roll casters have a limited alloy/product range - short freezing range alloys for fin, foil & building sheet.

Twin-belt casting (TBC)
Molten metal is fed into a nearly parallel cavity comprised of two, internally cooled, counter-rotating belts. The heat transfer is much lower than for TRC. Twin belt casters can be used for container stock, foil, fin, building products, and some medium strength alloys. It is now possible, with updated technology, to produce automotive stock in 5XXX and 6XXX series alloys.

Today strip casting represents a significant and increasing part of overall aluminium sheet production (>1 Million Tonnes/yr).

No single strip casting technology has yet been developed sufficiently well that it can meet all the property requirements for the full range of aluminium rolled products.

Significant opportunities for important technical developments in the strip casting of aluminium alloys remain.

Rolled aluminium is widely used in many industries including:

Aircraft: Structural members, cladding and many fitments.
Aerospace: Satellites, space laboratory structures and cladding.
Marine: Superstructures, hulls, interior fittings.
Rail: Structures, coach panelling, tankers and freight wagons.
Road: Car chassis & body panels, Buses, truck bodies, tippers, tankers, radiators, trim, traffic signs and lighting columns.
Building: Insulation, roofing, cladding and guttering.
Engineering: Welded structures, tooling plate, cladding and panelling, and heat exchangers.
Electrical: Transformer windings, busbars, cable sheathing, and switchgear.
Chemical: Process plant, vessels and chemical carriers.
Food: Handling and processing equipment, and hollowware.
Packaging: Cans, bottle caps, beer barrels, wrapping, packs and containers for a wide range of food and non-food products.
Printing: Lithographic plates

Rolled aluminium for general engineering specifications is supplied to BS EN 485 Parts 1-4 – plate, sheet and strip. Aerospace materials are covered by the “L” series of British Standards and by the BS EN Aerospace Series.

Much of the UK market for rolled aluminium, except for a number of speciality products such as can stock, lithographic sheet and packaging foil, can be supplied to manufacturers through members of the Aluminium Stockholders Association. This important distribution network is of major importance, particularly as the mills seek further and further scales of economy in production by rolling bigger and bigger ingots. Supplying the UK market with its aluminium requirements is increasingly becoming a partnership approach, with the stockist providing the important “Just-in-Time” link in the chain to ensure manufacturers get the aluminium they need in whatever form, exactly when they need it, with minimum stocks.
### Selection of Rolling Alloys

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<th>Alloy Designation</th>
<th>Characteristics</th>
<th>Typical Applications</th>
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<tr>
<td>3004 (No former BS designation)</td>
<td>Al-Mn and Al-Mn-Mg 3000 Series alloys provide a wide range of mechanical properties and very good corrosion resistance, weldability and formability. The strength/formability characteristic is achieved by application of various degrees of strain hardening and by intermediate annealing. Alloy 3004 as well 3104 alloy are the 2 alloy types use for beverage can body stock.</td>
<td>Siding, can stock, packaging, lamp bases. Sheet-metal work, storage tanks, trailer panel sheet.</td>
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<tr>
<td>7075 (Former BS designation 2L95)</td>
<td>Heat treatable very high strength alloy with a strength slightly lower than 7010. Very high fatigue strength. Joining preferably by rivets, adhesives or screws. Corrosion protection is recommended also in outdoor atmosphere.</td>
<td>Usually in plate form. Aircraft and military highly stressed structural components. Rolling stock for machine parts and tools (for rubber and plastics). Ski poles, tennis rackets, screws and bolts, nuts. Rivets. Nuclear applications.</td>
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Further information about aluminium and aluminium alloys, their production, fabrication and end use can be obtained from:

(1) European Aluminium Association in Brussels  
www.eaa.net

(2) International Aluminium Institute in London  
www.world-aluminium.org