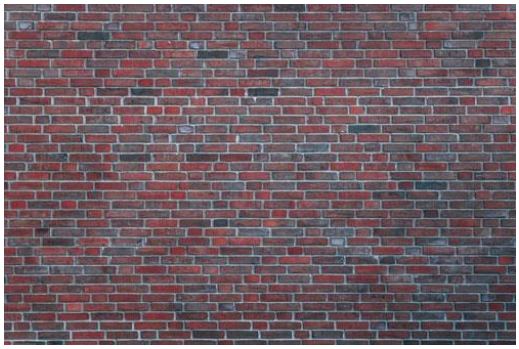
ALUMINIUM – THE METAL

Introduction

Metallic aluminium is not found in nature, it occurs in the form of hydrated oxides or silicatesor as complex clays. Aluminium is the third most abundant element in the earth's crust.

Element	Chemical Symbol	% Natural Abundance
Oxygen	O	47.3
Silicon	Si	27.7
Aluminium	Al	7.9
Iron	Fe	4.5
Calcium	Ca	3.5

However, it is too difficult to economically extract aluminium from most clays. A common clay brick wall contains 10 to 20 kilograms of aluminium per square metre.



Aluminium oxide gives China Clay kaolin its white colour.

Bauxite

The only clay from which aluminium can be economically extracted is bauxite.
Bauxite is a rock formed from laterite soil that has been severely leached over millennia of silica and other soluble materials in wet tropical or subtropical climate. Bauxite has no specific composition, it is a mixture of hydrous aluminium oxides, aluminium hydroxides, clay minerals and insoluble materials. Globally Bauxite reserves have been estimated at 40 to 75 Billion tons.

Bauxite globally sources

- Australia 31%
- China 16%
- Brazil 14%
- Indonesia 12%

- Guinea 7%
- India 6%

History of Aluminium

Pliny the Elder, a Roman scientist, died on August 25, AD 79, in his book “Historica Naturalis” told the story of a first century craftsman presenting to Tiberius, the Roman Emperor, a cup made of an unknown metal looking like silver, but too light to be silver, In “Historica Naturalis” Pliny the Elder, gave the name ‘Alumen’ to alum, a mineral containing a compound of Aluminium and Sulphur.

In 1807, Sir Humphrey Davy, the British scientist, established the existence of the element aluminium. Incidentally, he called his elusive element “Alumium” but four years later changed this to "Aluminum", the spelling which is still used in the USA. Following Davy's work, H C Oersted of Denmark isolated small lumps of the metal by heating potassium amalgam with aluminium chloride. By 1845 Wohler, a German scientist, had established a range of properties, including the determination of aluminium's specific gravity, the property which paved the way for the industrial development of aluminium, its lightness!

In France between 1855 and 1886, Henri Sainte-Claire Deville developed a chemical production process for aluminium production, which together with some other subtle variations in other European countries, formed the basis for production of aluminium as a high-cost, luxury metal in limited quantities.

In 1886, "the great leap forward" for the aluminium industry occurred. In this year, Charles Martin Hall in the United States of America, and Paul L T Heroult in France, each perfected, quite independently, the electrolytic method for producing aluminium from aluminium oxide (alumina). Their success was compounded in 1888 by the German Karl Bayer improving a cheap production method for alumina from bauxite ore. Almost overnight the price of aluminium plunged from $18 to $4.50 per kg. Aluminium and its attractive properties were now well within the reach of any interested industrialist.

Using the new processes every advanced industrial country had established a fledgling industry by the end of the nineteenth century.

Aluminium Properties

The wide and versatile properties of aluminium have established it as global designers’ metal of choice, substituting for and displacing other metals, materials, plastics, and carbon fibre.

- Aluminium has one of the lowest melting temperatures of all metals 660°C.
- A key property is low density. Aluminium is only one-third the weight of steel.
- Aluminium alloys and tempers can match ductility and strength of body in white, chassis automotive and architectural steels with typically 45% weight saving.
- Aluminium, and most of its alloys, is highly resistant to most forms of corrosion. The metal's natural coating of aluminium oxide provides a highly effective barrier to the ravages of air, temperature, moisture, and chemical attack, making aluminium a useful construction material.
- Aluminium is a superb conductor of electricity. Aluminium has 61% the conductivity of Copper on a volume basis, 200% the conductivity of Copper on a weight basis.
- Aluminium is non-magnetic and non-combustible, properties invaluable in advanced industries such as electronics or in offshore structures.
- Aluminium has 57% the thermal conductivity of Copper on a volume basis, but nearly 200% the conductivity of copper on a weight basis.

- Aluminium is non-toxic and impervious, qualities that have established its use in the food and packaging industries since the earliest times.
- Odourless.
- Can reflect up to 90% of white light and heat.
- Aluminium is easily recycled, and can be recycled repeatedly without loss of quality, making it a highly sustainable material.

Other valuable properties include high reflectivity and heat barrier properties.

Alloys

The use of aluminium really starts from the early 1990's and to date one billion tons have been produced, of which 75% is still in use with 50% remarkably in first use.

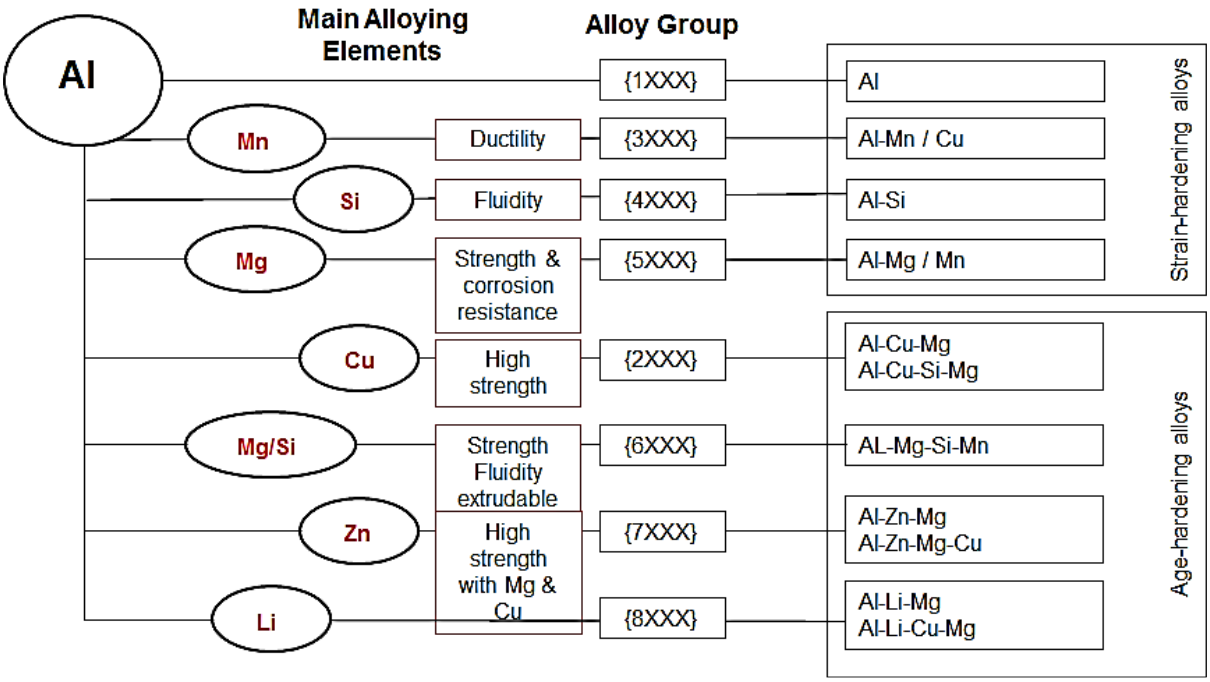
Given that it is a young metal, its growth and applications have been underpinned by the simultaneous development of metallurgy. Thus aluminium alloys have been developed in a scientific manner in responce to a specific need or demand for properties. The composition and logic of those alloys are regulated by an internationally agreed classifications system or nomenclature for wrought and for cast alloys.

The wrought alloy scheme, as adopted by the British Standards Institution, by CEN and by the other standards organisations globally, is that each registered alloy is described by a four digit number, with a further letter and number indicating the temper, or condition of the alloy, For example, 6082-T6 is a medium strength grade alloy based on the aluminium-magnesium-silicon family, in the fully heat-treated condition.

The first of the four digits in the designation indicates the alloy group, according to the major alloying elements. Further digits explain other alloying elements.

- 1xxx Unalloyed (pure) greater than 99% Aluminium
- 2xxx Copper
- 3xxx Manganese
- 4xxx Silicon
- 5xxx Magnesium
- 6xxx Magnesium and Silicon
- 7xxx Zinc
- 8xxx Other elements (Tin and Lithium)

Each alloy group was developed for specific properties. These alloys groups fall into two main groups. The work-hardening alloys, such as the 3000 series, where strength is achieved by the amount of "cold work" e.g. by rolling, and the heat-treatable or precipitation hardening alloys, such as the 6000 series, where the strength and properties are achieved by heat treatment.



Further information about aluminium and aluminium alloys, their production, fabrication and end use can be obtained from:

- Aluminium Federation www.alfed.org.uk
- European Aluminium Association in Brussels www.european-aluminium.eu
- International Aluminium Institute in London www.world-aluminium.org