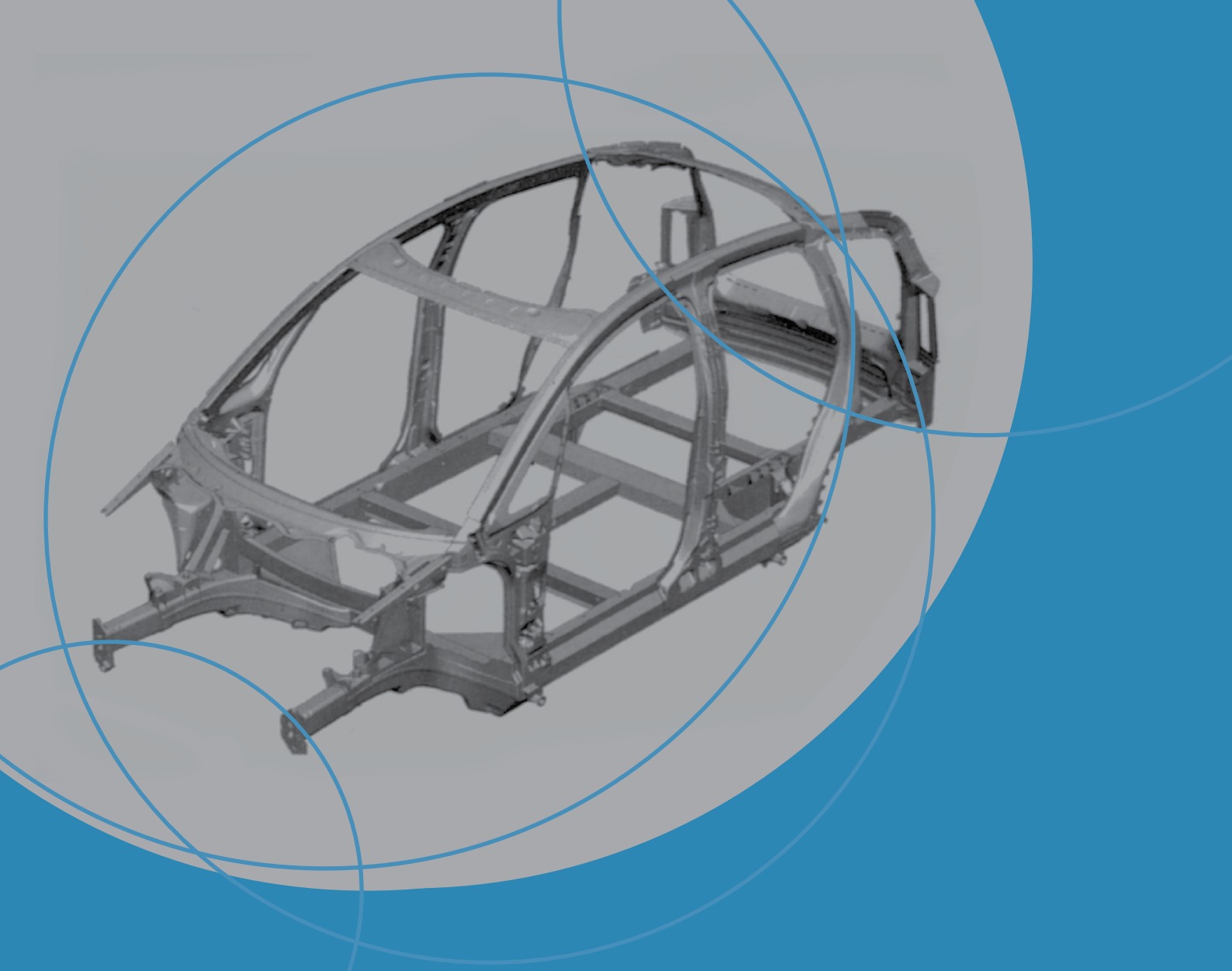

UK Aluminium Industry Fact Sheet 6

Aluminium - The Metal

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Introduction

More aluminium is produced each year than any other non-ferrous metal. For this reason, it is difficult to believe that aluminium was only discovered some 200 years ago and has been produced in industrial quantities for only the last 120+ years.

Aluminium is the third most abundant element in the earth's crust. So, why has it not been used for centuries, as has gold or copper? The main answer is that it is never found in its natural form as a pure metal. Aluminium is always locked in, or mixed with, other elements. Aluminium occurs in most rocks, vegetation, soils etc., in this combined form as very stable chemical compounds such as alumino-silicates.

The Ten Most Naturally Abundant Elements

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
Sodium	Na	2.5
Potassium	K	2.5
Magnesium	Mg	2.2
Titanium	Ti	0.5
Hydrogen	H	0.1

Some aluminium-bearing compounds were used by man from the earliest times. Primitive man made pottery from clays containing hydrated aluminium silicate. The Egyptians and Babylonians used aluminium salts for the preparation of dyes and medicines.

In 1807, Sir Humphrey Davy, the British scientist, established the existence of the element aluminium. Incidentally he called his elusive element "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.

The Properties

Aluminium has been termed "The Magic Metal" or "The Wonder Metal". The reasons for these accolades lie in the very diverse range of physical, chemical and mechanical properties enjoyed by the metal and its alloys in both cast or wrought forms:-

- A key property is low density. Aluminium is only one-third the weight of steel.
- 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. This property, allied with other intrinsic qualities, has ensured the replacement of copper by aluminium in many electrical applications.
- Aluminium is non-magnetic and non-combustible, properties invaluable in advanced industries such as electronics or in offshore structures.
- Aluminium is non-toxic and impervious, qualities that have established its use in the food and packaging industries since the earliest times.

- Aluminium is strong and ductile, properties that, combined with low density, have resulted in extensive use of aluminium in transport applications.
- 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, heat barrier properties and heat conduction. The metal is malleable and easily worked by the common manufacturing and shaping processes.

Alloys

All the above properties can be found in an impressive array of commercially available alloys. The composition and logic of those alloys are regulated by an internationally agreed classifications system or nomenclature for wrought alloys and by various domestic nomenclature schemes for the casting alloys.

The wrought alloy scheme, as adopted by the British Standards Institution, by CEN and by the other standards organisations globally, is as follows. 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 classification provides for:-

1XXX	Aluminium of 99% minimum purity
2XXX	Aluminium-copper alloys
3XXX	Aluminium-manganese alloys
4XXX	Aluminium-silicon alloys
5XXX	Aluminium-magnesium alloys
6XXX	Aluminium-magnesium-silicon alloys
7XXX	Aluminium-zinc-magnesium alloys
8XXX	Miscellaneous alloys, e.g. aluminium-lithium alloys

Alloys fall into two main groups. The work-hardening alloys, such as the 3000 series, where strength is achieved by the amount of “cold work” applied to the alloy, 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 treatments of varying complexity.

Shaping

The above properties mean that aluminium and its alloys can be easily shaped by any of the industrial metalworking processes in common use. Typically these processes are rolling, extrusion, forging and casting. The first stage of availability of aluminium for these processes is usually round or rectangular ingot direct from the primary smelter or remelt facility.

With all its myriad applications, the aluminium industry has continued to grow year on year. Currently world production of primary aluminium is in excess of 40 million metric tonnes.

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

(1) European Aluminium Association in Brussels **http://www.eaa.net/en/about-aluminium**

(2) International Aluminium Institute in London **http://www.world-aluminium.org/About+Aluminium**