Aluminium is the world's most abundant metal and is the third most common element comprising 8% of the earth's crust. The versatility of aluminium makes it the most widely used metal after steel.
Aluminium is derived from the mineral bauxite. Bauxite is converted to aluminium oxide (alumina) via the Bayer Process. The alumina is then converted to aluminium metal using electrolytic cells and the Hall-Heroult Process.
Worldwide demand for aluminium is around 29 million tons per year. About 22 million tons is new aluminium and 7 million tons is recycled aluminium scrap. The use of recycled aluminium is economically and environmentally compelling. It takes 14,000 kWh to produce 1 tonne of new aluminium. Conversely it takes only 5% of this to remelt and recycle one tonne of aluminium. There is no difference in quality between virgin and recycled aluminium alloys.
Pure aluminium is soft, ductile, corrosion resistant and has a high electrical conductivity. It is widely used for foil and conductor cables, but alloying with other elements is necessary to provide the higher strengths needed for other applications. Aluminium is one of the lightest engineering metals, having a strength to weight ratio superior to steel.
By utilising various combinations of its advantageous properties such as strength, lightness, corrosion resistance, recyclability and formability, aluminium is being employed in an ever-increasing number of applications. This array of products ranges from structural materials through to thin packaging foils.

ALLOY DESIGNATIONS

Aluminium is most commonly alloyed with copper, zinc, magnesium, silicon, manganese and lithium. Small additions of chromium, titanium, zirconium, lead, bismuth and nickel are also made and iron is invariably present in small quantities.
There are over 300 wrought alloys with 50 in common use. They are normally identified by a four figure system which originated in the USA and is now universally accepted. Table 1 describes the system for wrought alloys. Cast alloys have similar designations and use a five digit system.

ALLOY DESIGNATIONS CONT...

Table 1.
Designations for wrought aluminium alloys.

Alloying Element None (99%+ Aluminium) - 1XXX
Alloying Element Copper - 2XXX
Alloying Element Manganese - 3XXX
Alloying Element Silicon - 4XXX
Alloying Element Magnesium - 5XXX
Alloying Element Magnesium + Silicon - 6XXX
Alloying Element Zinc - 7XXX
Alloying Element Lithium/Other - 8XXX

For unalloyed wrought aluminium alloys designated 1XXX, the last two digits represent the purity of the metal. They are the equivalent to the last two digits after the decimal point when aluminium purity is expressed to the nearest 0.01 percent. The second digit indicates modifications in impurity limits. If the second digit is zero, it indicates unalloyed aluminium having natural impurity limits and 1 through 9, indicate individual impurities or alloying elements.

For the 2XXX to 8XXX groups, the last two digits identify different aluminium alloys in the group. The second digit indicates alloy modifications. A second digit of zero indicates the original alloy and integers 1 to 9 indicate consecutive alloy modifications.

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REVISION HISTORY

Datasheet Updated	18 July 2019

DISCLAIMER

This Data is indicative only and as such is not to be relied upon in place of the full specification. In particular, mechanical property requirements vary widely with temper, product and product dimensions. All information is based on our present knowledge and is given in good faith. No liability will be accepted by the Company in respect of any action taken by any third party in reliance thereon.

Please note that the 'Datasheet Update' date shown above is no guarantee of accuracy or whether the datasheet is up to date.

The information provided in this datasheet has been drawn from various recognised sources, including EN Standards, recognised industry references (printed & online) and manufacturers' data. No guarantee is given that the information is from the latest issue of those sources or about the accuracy of those sources.

Material supplied by the Company may vary significantly from this data, but will conform to all relevant and applicable standards.

As the products detailed may be used for a wide variety of purposes and as the Company has no control over their use; the Company specifically excludes all conditions or warranties expressed or implied by statute or otherwise as to dimensions, properties and/or fitness for any particular purpose, whether expressed or implied.

Advice given by the Company to any third party is given for that party's assistance only and without liability on the part of the Company. All transactions are subject to the Company's current Conditions of Sale. The extent of the Company's liabilities to any customer is clearly set out in those Conditions; a copy of which is available on request.

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Physical Properties

Density

Aluminium has a density around one third that of steel or copper making it one of the lightest commercially available metals. The resultant high strength to weight ratio makes it an important structural material allowing increased payloads or fuel savings for transport industries in particular.

Strength

Pure aluminium doesn't have a high tensile strength. However, the addition of alloying elements like manganese, silicon, copper and magnesium can increase the strength properties of aluminium and produce an alloy with properties tailored to particular applications.

Aluminium is well suited to cold environments. It has the advantage over steel in that its' tensile strength increases with decreasing temperature while retaining its toughness. Steel on the other hand becomes brittle at low temperatures.

Corrosion Resistance

When exposed to air, a layer of aluminium oxide forms almost instantaneously on the surface of aluminium. This layer has excellent resistance to corrosion. It is fairly resistant to most acids but less resistant to alkalis.

Thermal Conductivity

The thermal conductivity of aluminium is about three times greater than that of steel. This makes aluminium an important material for both cooling and heating applications such as heat-exchangers. Combined with it being non-toxic this property means aluminium is used extensively in cooking utensils and kitchenware.

Electrical Conductivity

Along with copper, aluminium has an electrical conductivity high enough for use as an electrical conductor. Although the conductivity of the commonly used conducting alloy (1350) is only around 62% of annealed copper, it is only one third the weight and can therefore conduct twice as much electricity when compared with copper of the same weight.

Reflectivity

From UV to infra-red, aluminium is an excellent reflector of radiant energy. Visible light reflectivity of around 80% means it is widely used in light fixtures. The same properties of reflectivity makes aluminium ideal as an insulating material to protect against the sun's rays in summer, while insulating against heat loss in winter.

Table 2. Typical properties for aluminium.

Property	Value
Atomic Number	13
Atomic Weight (g/mol)	26.98
Valency	3
Crystal Structure	FCC
Melting Point (°C)	660.2
Boiling Point (°C)	2480
Mean Specific Heat (0-100°C) (cal/g.°C)	0.219
Thermal Conductivity (0-100°C) (cal/cms. °C)	0.57
Co-Efficient of Linear Expansion (0-100°C) ($\times10^{-6}$/°C)	23.5
Electrical Resistivity at 20°C (µΩ.cm)	2.69
Density (g/cm^3)	2.6898
Modulus of Elasticity (GPa)	68.3
Poissons Ratio	0.34

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Mechanical Properties

Aluminium can be severely deformed without failure. This allows aluminium to be formed by rolling, extruding, drawing,

machining and other mechanical processes. It can also be cast to a high tolerance.

Alloying, cold working and heat-treating can all be utilised to tailor the properties of aluminium.

The tensile strength of pure aluminium is around 90 MPa but this can be increased to over 690 MPa for some heat-treatable alloys.

Table 3. Mechanical properties of selected aluminium alloys.

Alloy	Temper	Proof Stress 0.2% (MPa)	Tensile Strength (MPa)	Shear Strength (MPa)	Elongation A5 (%)	Hardness Vickers (HV)
AA1050A	H12	85	100	60	12	30
	H14	105	115	70	10	36
	H16	120	130	80	7	-
	H18	140	150	85	6	44
	0	35	80	50	42	20
AA2011	T3	290	365	220	15	100
	T6	300	395	235	12	115
AA3103	H14	140	155	90	9	46
	0	45	105	70	29	29
AA4015	0	45	110-150	-	20	30-40
	H12	110	135-175	-	4	45-55
	H14	135	160-200	-	3	-
	H16	155	185-225	-	2	-
	H18	180	210-250	-	2	-
AA5083	H32	240	330	185	17	95
	0/H111	145	300	175	23	75
AA5251	H22	165	210	125	14	65
	H24	190	230	135	13	70
	H26	215	255	145	9	75
	0	80	180	115	26	46
AA5754	H22	185	245	150	15	75
	H24	215	270	160	14	80
	H26	245	290	170	10	85
	0	100	215	140	25	55
AA6063	0	50	100	70	27	85
	T4	90	160	11	21	50
	T6	210	245	150	14	80
AA6082	0	60	130	85	27	35
	T4	170	260	170	19	75
	T6	310	340	210	11	100
AA6262	T6	240	290	-	8	-
	T9	330	360	-	3	-
AA7075	0	105-145	225-275	150	9	65
	T6	435-505	510-570	350	5	160

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Aluminium Standards

The old BS1470 standard has been replaced by nine EN standards. The EN standards are given in table 4.

Table 4. EN standards for aluminium

Standard	Scope
EN485-1	Technical conditions for inspection and delivery
EN485-2	Mechanical properties
EN485-3	Tolerances for hot rolled material
EN485-4	Tolerances for cold rolled material
EN515	Temper designations
EN573-1	Numerical alloy designation system
EN573-2	Chemical symbol designation system
EN573-3	Chemical compositions
EN573-4	Product forms in different alloys

The EN standards differ from the old standard, BS1470 in the following areas:

- Chemical compositions – unchanged.
- Alloy numbering system – unchanged.
- Temper designations for heat treatable alloys now cover a wider range of special tempers. Up to four digits after the T have been introduced for non-standard applications (e.g. T6151).
- Temper designations for non heat treatable alloys – existing tempers are unchanged but tempers are now more comprehensively defined in terms of how they are created. Soft (O) temper is now H111 and an intermediate temper H112 has been introduced. For alloy 5251 tempers are now shown as H32/H34/H36/H38 (equivalent to H22/H24, etc). H19/H22 & H24 are now shown separately.
- Mechanical properties – remain similar to previous figures. 0.2% Proof Stress must now be quoted on test certificates.

Tolerances have been tightened to various degrees.

Heat Treatment

A range of heat treatments can be applied to aluminium alloys:

- Homogenisation – the removal of segregation by heating after casting.
- Annealing – used after cold working to soften work-hardening alloys (1XXX, 3XXX and 5XXX).
- Precipitation or age hardening (alloys 2XXX, 6XXX and 7XXX).
- Solution heat treatment before ageing of precipitation hardening alloys.
- Stoving for the curing of coatings

After heat treatment a suffix is added to the designation numbers.

- The suffix F means "as fabricated".
- O means "annealed wrought products".
- T means that it has been "heat treated".
- W means the material has been solution heat treated.
- H refers to non heat treatable alloys that are "cold worked" or "strain hardened".

The non-heat treatable alloys are those in the 3XXX, 4XXX and 5XXX groups.

Table 5. Heat treatment designations for aluminium and aluminium alloys.

Term	Description
T1	Cooled from an elevated temperature shaping process and naturally aged.
T2	Cooled from an elevated temperature shaping process cold worked and naturally aged.
T3	Solution heat-treated cold worked and naturally aged to a substantially.
T4	Solution heat-treated and naturally aged to a substantially stable condition.
T5	Cooled from an elevated temperature shaping process and then artificially aged.
T6	Solution heat-treated and then artificially aged.
T7	Solution heat-treated and overaged/stabilised.

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Work Hardening

The non-heat treatable alloys can have their properties adjusted by cold working. Cold rolling is a typical example.

These adjusted properties depend upon the degree of cold work and whether working is followed by any annealing or stabilising thermal treatment.

Nomenclature to describe these treatments uses a letter, O, F or H followed by one or more numbers. As outlined in Table 6, the first number refers to the worked condition and the second number the degree of tempering.

Table 6. Non-Heat treatable alloy designations

Term	Description
H1X	Work hardened
H2X	Work hardened and partially annealed
H3X	Work hardened and stabilized by low temperature treatment
H4X	Work hardened and stoved
HX2	Quarter-hard – degree of working
HX4	Half-hard – degree of working
HX6	Three-quarter hard – degree of working
HX8	Full-hard – degree of working

Table 7. Temper codes for plate

Code	Description
H112	Alloys that have some tempering from shaping but do not have special control over the amount of strain-hardening or thermal treatment. Some strength limits apply.
H321	Strain hardened to an amount less than required for a controlled H32 temper.
H323	A version of H32 that has been specially fabricated to provide acceptable resistance to stress corrosion cracking.
H343	A version of H34 that has been specially fabricated to provide acceptable resistance to stress corrosion cracking.
H115	Armour plate.
H116	Special corrosion-resistant temper.

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