



## Aluminium Alloy - Glossary of Terms for Aluminium

An extensive glossary of the many terms used in relation to aluminium and its alloys

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## Aluminium Alloy - Glossary of Terms for Aluminium

**Ageing**

Hardening caused by the precipitation of a constituent from a super-saturated solid solution.

**All-over marking**

A method of identifying sheet, plate and strip by printing at close intervals over the surface the name or symbol of the manufacturer, the relevant specification number and, in some cases, the temper and thickness of the material.

**Alloying element**

An element intentionally introduced in controlled quantity into a base metal or an alloy.

**Aluminium alloy**

A metallic substance, consisting of an intentional admixture of elements, the predominant element being aluminium.

**Angle**

The relative orientation of two adjacent faces of a section generally measured over the full Length of both.

**Annealing**

Thermal treatment intended to soften a metal or alloy hardened by cold work or artificial ageing.

**Anodizing**

An electrochemical method of producing an integral oxide film on aluminium surfaces. The thickness and other film characteristics can be controlled to meet varied requirements for improved corrosion resistance, improved abrasion resistance, electrical insulation or as a pré-treatment for subsequently applied coatings.

**Anodizing quality material**

Material with characteristics that make it suitable for decorative anodizing after suitable preliminary treatment. As a general rule the purer the aluminium alloy the better it will anodise.

**Anodizing test**

A non-destructive test for detecting certain defects in material that is anodized and rinsed. If cracks or other superficial flaws are present in the material they retain some of the chromic acid solution which subsequently seeps out and stains the anodic film.

**Architectural anodizing**

Anodizing to be used in permanent, interior, exterior and static situations where both attractive appearance and long life are essential.

**Arrested mandrel**

A mandrel attached to an auxiliary extrusion ram. As the main ram moves forward the mandrel is held stationary in the die, resulting in a product of uniform wall thickness along the length.

**Artificial ageing**

Thermal treatment of an alloy that increases precipitation treatment the hardness and strength by precipitation of constituents from the super-saturated solid solution at above room temperature.

**As-quenched condition**

The condition of an alloy during the time immediately following the quench and before the mechanical properties have been significantly raised by precipitation hardening.

**Back end defect**

A longitudinal discontinuity in the extreme extrusion defect rear portion of an extruded product that is normally discarded.



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**Back extrusion**

A process in which a heated ingot in an enclosed container is extruded backwards over the mandrel and supporting stem.

**Bar**

A round, rectangular or regular polygonal solid section supplied in straight lengths. The term is applied to materials of not less than 6mm diameter or minor dimension.

**Barrelling**

The treatment of articles in a rotating tumbling container in the presence of abrasives and water for deburring or to produce a variety of surface textures.

**Batch**

Consignment, or a part thereof, comprising products of the same grade or alloy, temper and thickness or cross section, processed in the same manner.

**Bend radius**

The radius of curvature of the former around which a specimen is bent.

**Bend test**

The bending of a specimen to conform with a predetermined radius and angle, to assess bending characteristics and ductility.

**Billet (Also often called a bloom)**

A semifinished product of square, rectangular, or round section, hot rolled, or forged. Producing billets or blooms from ingots by forging is called cogging, while by rolling is called blooming.

**Bite mark**

A mark on the roll coating caused by the initial feeding of the ingot, which is subsequently transferred to the hot rolled slab.

**Blank**

A piece of metal prepared for subsequent fabrication by forming, bending, cupping, drawing, impact extrusion, pressing, etc.

**Blanking**

The production of circles and other shapes by shearing on a blanking press.

**Blanking die**

A die used for shearing circles and other blanks.

**Blanking press**

A press used for shearing blanks from plate, sheet or strip.

**Blast cleaning**

The projection of abrasive grit, sand, small grit blasting particles of steel, glass or other materials, sand blasting or a mixture of abrasive grit, water and air, shot blasting to strike the surface of an article in order vapour blasting to clean it. A matt or satin finish is produced, depending upon the particle size used.

**Blister**

A raised area on the surface of the metal caused by the expansion of a gas enclosed in a sub-surface void.

**Bolt stock**

Round bar or wire suitable for the manufacture of bolts.



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**Bond blister**

A blister at the interface between the coating and the core of clad products.

**Bore test**

A test on tube to verify freedom from constriction by passing a metallic bob or wire of specified dimensions through the tube.

**Bow**

The deviation, in the form of an arc, of the longitudinal axis of a product.

**Bored extrusion ingot**

An extrusion ingot with a central bored extrusion billet longitudinal hole produced by machining.

**Brazing rod**

Rod of an alloy with a low melting range for use as filler metal in brazing.

**Brazing sheet**

Sheet of a low melting range alloy or clad with a low melting range alloy, used for brazing.

**Brazing strip**

Strip of a low melting range alloy or clad with a low melting range alloy, used for brazing.

**Brazing wire**

Wire of an alloy with a low melting range for use as filler metal in brazing.

**Breaking down**

The initial hot-working operation whereby a heavy reduction is given to rolling ingot or cast forging stock.

**Bright anodizing**

Anodizing with brightness as a primary objective.

**Buckle**

Departure from flatness represented by alternate bulges and hollows along the length of a rolled product, the edges of which remain reasonably flat.

**Bull block**

A machine for drawing rod, bar and tube in coil form through one die.

**Burr**

A thin ridge of roughness on an edge left by a cutting operation such as slitting, trimming, shearing, blanking, sawing etc.

**Busbars**

Bar or section for use as a common junction between electrical circuits.

**Cast**

Metal taken from the same melt in a furnace or crucible, or of several melts mixed in the same furnace or crucible before pouring, or metal taken from a furnace without subsequent addition (when a continuous melting process is used). In the case of continuous or semicontinuous casting procedures this is also regarded as the product of a cycle up to 24 h where the same alloy and shape is cast.

**Chatter marks**

Regularly spaced superficial transverse markings produced by vibration between the metal and the working surface during fabrication.



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**Chemical brightening**

Chemical treatment to improve the specular reflectivity of a surface.

**Chemical conversion coating**

Treatment of material with chemical solutions dipping or spraying to increase the thickness of the natural oxide film on the surface or to build up an oxide film bearing chromates or phosphates.

**Chill casting**

A process in which molten metal is poured into a permanent mould and solidified.

**Circle**

A circular blank fabricated from plate, sheet or foil.

**Circumscribing circle**

A circle that will just contain the cross section of an extrusion, usually designated by its diameter.

**Clad material**

Material that has a thin layer of aluminium or aluminium alloy metallurgically bonded to it usually by rolling, extruding or drawing.

**Clipper die**

A die used for removing the flash from stampings trimmer die and forgings.

**Clipping**

The removal of the flash from drop stampings and pressings.

**Close-to-form forging**

A die forging of such dimensional accuracy that subsequent machining is eliminated or reduced to a minimum.

**Closed die**

Forging dies, usually in pairs, into which impressions have been cut to impart the required shape.

**Coating blister**

A blister in the coating of a clad product.

**Coining**

A final cold forging operation applied to obtain close tolerances.

**Cold compression**

Working of forged material at room temperature under compression through the thickness in the solution treated condition immediately after quenching to relieve internal stresses caused by quenching, and to minimize distortion during machining.

**Cold working**

Modification of a metal structure by working work hardening at room temperature or moderate temperatures, strain hardening resulting in an increase in strength and hardness with a general loss of ductility.

**Colour anodizing**

Incorporation of colouring matter either during anodizing or by subsequent processing into the film of anodized aluminium.

**Concavity**

An inward curvature across the width of a surface of a rolled or extruded product.





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**Concentricity**

Uniformity of wall thickness throughout the cross section of a tube. The tolerance on concentricity is established by the wall thickness tolerance.

**Conductor wire**

Wire possessing the requisite electrical and mechanical properties for use as an electrical conductor.

**Container**

A hollow cylinder in an extrusion press from which the ingot is extruded.

**Container stock sheet**

Thin sheet used for the fabrication of packing can stock sheet containers and closures by pressing or forming operations.

**Continuous casting**

A process in which liquid metal is solidified rapidly in a water-cooled mould or die and continuously withdrawn and cut while the mould is being simultaneously replenished with liquid metal.

**Control bar**

A forged test bar in a given alloy, of known response to heat treatment, that is included in a furnace load to check the effectiveness of the heat treatment operation.

**Controlled atmosphere**

An atmosphere in which the concentration, temperature and pressure of constituents are maintained within controlled limits so as to minimize (or more rarely induce) certain reactions between the atmosphere and the material treated, e.g. oxidation.

**Controlled stretching**

Stretching to effect a specified extension (percentage permanent set) in order to relieve internal stress and to minimize distortion during machining.

**Convexity**

An outward curvature across the width of a surface of a rolled or extruded product.

**Cooling curve**

A curve showing the relationship between time and temperature during the cooling of a metal.

**Core blister**

A blister in the core of clad material.

**Corner radius**

The radius of an arc to which adjacent sides of a product are tangential.

**Corrosion**

The deterioration of a metal by chemical or electrochemical reaction with its environment.

**Critical quenching rate**

The minimum mean cooling rate from solution treatment temperature necessary to enable an alloy to meet specified mechanical property requirements in the precipitation hardened condition.

**Cropping**

The removal, by shearing or sawing, of the ends of cast or semifabricated products at an intermediate stage of processing.



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**Crown**

The difference in thickness between one edge and the centre of a rolled product.

**Cut-up test**

A destructive test carried out on forgings to verify details of the grain flow and mechanical properties in various positions in the forgings.

**Decking corrugated sheet**

Formed sheet, usually of asymmetrical profile, having narrow, steep-sided troughs interspaced with wide flats.

**Deep drawing**

The forming of deeply recessed parts by means of plastic deformation of the material.

**Deep drawing sheet**

Specially produced sheet with characteristics that make it suitable for deep drawing.

**Deep drawing strip**

Specially produced strip with characteristics that make it suitable for deep drawing.

**Degreasing**

The removal of oil or grease, usually by a suitable organic solvent or an aqueous detergent.

**Delayed ageing**

Natural ageing delayed by keeping an alloy at a delayed age hardening temperature below room temperature. After returning to room temperature the natural ageing process continues normally.

**Desensitization**

Heating for a relatively long period at a temperature generally above 200 C, applied to certain non-heat treatable alloys in order to reduce their susceptibility to stress corrosion.

**Detwisting**

An operation designed to remove torsional deviations from the transverse axis along the length of an extrusion.

**Die forging**

A forging shaped by working in closed dies.

**Die lines**

Continuous longitudinal lines formed on extruded or drawn products by minor irregularities on the bearing surfaces of the die.

**Die scores**

Relatively deep continuous longitudinal lines on extruded or drawn products caused by the build-up of aluminium on the bearing surface of the die.

**Differential annealing**

The heating of blanks so that the peripheral annulus or other specified parts only are annealed.

**Diffusion in clad material**

Diffusion of the alloying constituents from the core to the cladding during thermal treatment.

**Diffusion staining**

Patchy discoloration that may arise from diffusion in clad material.



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**Dimensional tolerance**

An allowable amount of deviation from a specified geometrical characteristic.

**Direct chill (DC) casting**

A casting technique in which the metal is solidified in a water-cooled open-ended mould from the bottom of which water is directly applied to the emerging ingot.

**Direct extrusion**

A process in which an ingot in the container is forced under pressure through an aperture in a stationary die.

**Directional properties**

The mechanical properties of a product in various directions with respect to the grain flow.

**Dished edges**

Departure from flatness associated with edge distortion during shearing, slitting or blanking.

**Double skin**

A thin surface layer separated from the parent material by a film of oxide or other foreign matter and originating during extrusion, sometimes described as a sub-surface defect.

**Draft angle**

Taper on the sides of die impressions and forgings to facilitate removal of the forgings from the die.

**Draw bench**

A machine for drawing bar, rod, sections and tubing in straight lengths.

**Draw plug**

A plug used in drawing tube to control the draw bulb internal dimensions.

**Drawing**

The process of pulling material through a die to reduce the size, change the cross section or shape, or work harden the material.

**Drawing die**

A block of steel, or block containing a hard insert, with a hole of the required contour through which the product is pulled.

**Drawing out**

Increasing the length and reducing the cross-sectional area of forging stock by working under a hammer or press.

**Drawn tube**

A hollow product of uniform wall thickness, produced by cold drawing from tube bloom.

**Drift expanding test / Drift Test**

The diametrical expansion of the end of a tube sample to a predetermined amount by the insertion of a cone, to assess the quality of the tube. For 'welded' aluminium scaffolding tube this test is carried out to BS1139.

**Drop forging**

A die forging produced between a stationary bottom die and a free-falling weighted top die.

**Drop hammer**

A forging machine in which the force of the blow is derived from a free-falling weighted top die.





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**Drop stamping**

A drop forging produced between closed dies.

**Duplex ageing**

Artificial ageing carried out in two successive stages at different temperatures.

**Dye penetrant test**

A non-destructive test in which clean and degreased material is immersed in or covered by a dye penetrant for a specified period. After the residual superfluous penetrant has been removed and a developer applied, the dye seeps out from any flaws and cracks, thereby making them easily visible.

**Earing**

Wavy projections spaced symmetrically around the rim of a deep drawn article due to variation in directional properties.

**Eddy current test**

A non-destructive test in which the impedance of a coil carrying an alternating current, which surrounds an article will vary with the characteristics of that article and thus can sometimes be used for the assessment of specific characteristics, e.g. internal soundness and thickness of anodic film.

**Electrical conductivity**

The reciprocal of electrical volume resistivity. Electrical conductivity is often expressed in terms of percentage of the International Annealed Copper Standard.

**Electrical volume resistivity**

The resistance of a specimen of unit length electrical resistivity and unit cross-sectional area of a given volume resistivity material.

**Electrochemical**

Electrochemical treatment to improve the brightening specular reflectivity of a surface.

**Embossed finish**

A pattern mechanically impressed on a surface by rolling or pressure.

**Embossed sheet**

Sheet with embossed finish.

**Equiaxed grains**

Grains or crystals that have approximately the same dimensions in three axial directions.

**Equivalent round**

The diameter of a circle whose area is equal to the cross-sectional area of an extruded or drawn section.

**Etching**

The production of a uniform matt finish by controlled chemical (acid or alkali) or electrochemical attack.

**Etching test**

The treatment of a sample using a chemical reagent to reveal the macro-structure of the material.

**Extruded round tube**

A circular hollow extrusion of uniform wall thickness not subjected to cold drawing.



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**Extruded section**

An extruded solid or hollow shape excluding bar, round tube and wire.

**Extrusion die**

A block of tool steel having one or more holes of the required contour through which an extrusion ingot is forced.

**Extrusion effect**

A characteristic non-recrystallized core in certain alloys that have been extruded. This results in higher tensile properties in the longitudinal direction than are obtained with the same alloys when in other wrought forms.

**Extrusion ingot**

A cylindrical or rectangular casting used Extrusion billet for extrusion. NOTE: See also hollow extrusion Ingot.

**Extrusion press**

A machine consisting essentially of a container, a ram or other pressure-applying device, and a die, used for the production of extrusions.

**Extrusion ratio**

The ratio of the cross-sectional area of the extrusion container to that of the extruded product.

**Fettling**

The removal of unwanted metal from a forging at any stage of production.

**Fin**

A thin flange of excess metal squeezed out between the rolls in the production of hot rolled rod.

**Finishing die**

A die used during the final forging operation.

**First-off forging**

An initial sample made from new dies and used for checking dimensional and metallurgical quality.

**Fixed mandrel**

A tapered mandrel attached to the main extrusion ram. As the latter moves forward the mandrel passes through the hollow ingot and die giving a product slightly tapering in wall thickness along the length.

**Flanging test**

A test in which a disc-shaped rim of predetermined size is formed at the end of a tube sample to assess its suitability for the manufacture of tubular rivets.

**Flash**

A thin flange of excess metal squeezed out between the die faces in the production of a die forging.

**Flash annealing**

Annealing carried out by heating quickly and holding for a short time at an appropriate temperature.

**Flash line**

The line on a stamping or pressing corresponding parting line to the plane of contact between the dies used in the process of manufacture.

**Flashless forging**

A forging produced within totally enclosed dies that preclude the exudation of excess metal between the parting faces of the dies. NOTE: See also flash and flash line.



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**Flattened wire**

Material produced by flattening round wire between rolls.

**Flattening**

The removal of deformation in plate, sheet or strip in order to produce a flat product. The operation is carried out by stretching, local reverse bending, etc.

**Flattening test**

A test in which a tube sample is flattened in a direction perpendicular to the longitudinal axis until the diameter or major axis is reduced to a predetermined value.

**Flatness**

The extent to which the surface of a product approaches a true plane.

**Floating mandrel**

A tapered mandrel, that is not attached to, but moves forward with, the main extrusion ram and that is left free to centre itself in a hollow extrusion ingot. The resulting product tapers slightly in wall thickness along the length.

**Fluorescent penetrant test**

A dye penetrant test for detecting flaws and cracks using a fluorescent dye with subsequent examination of the dried material under ultraviolet radiation.

**Foil**

A cold-rolled product of rectangular section thickness not greater than 0.2mm.

**Foil-stock**

Semi-finished coiled strip for further rolling to foil.

**Forged ring**

A ring of regular cross section produced by either trunnioning or rolling, which results in the principal direction of grain flow being circumferential, i.e. concentric with the ring.

**Forging**

A shape produced by hammering or pressing, usually when hot, between open or closed dies.

**Forging ingot**

A solid circular or rectangular casting used for subsequent forging.

**Forging mandrel**

A cylindrical bar on which a forged ring is expanded by the process of trunnioning.

**Forging stock**

A rod, bar or other wrought section suitable for forging.

**Formed section**

Section produced from strip by roll-forming or drawing, or both, or from sheet by the use of a press brake.

**Fracture test**

A test in which a piece of metal is notched and broken, and the fractured surface examined in order to assess grain structure and freedom from defects.

**Free machining alloy**

An alloy that, by virtue of its chemical composition and condition, is designed to give, on machining, small broken chips, lower power consumption, better surface finish and/or longer tool life.



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**Frosted finish**

A white, slightly specular finish produced by etching.

**Full heat treatment**

Solution treatment followed by artificial ageing.

**Gauge length**

The prescribed part of the cylindrical or prismatic portion of the testpiece on which elongation is measured at any moment during the test. In particular, a distinction should be made between the following:

- (a) the original gauge length ( ), gauge length before the test piece is strained; and
- (b) the final gauge length ( ), gauge length after the test piece has been fractured and the fractured parts have been carefully fitted together so that they lie in a straight line.

**General purpose**

Formed sheet with symmetrical, near-sinusoidal corrugated sheet profile 19mm deep at 76.2mm pitch.

**Grain flow**

Elongation of the grain structure in the direction of working.

**Grain growth**

The coarsening of the grain structure occurring under certain conditions of heating.

**Grain size**

The mean size of metal grains usually expressed in terms of the number of grains per unit area or as the mean grain diameter.

**Grey plate finish**

A matt finish produced by a special rolling technique.

**Hammer forging**

A forging produced by repeated blows in a forging hammer.

**Hand forging**

A forging produced by manipulating metal between open dies.

**Hard anodizing**

Anodizing under special conditions to produce a hard film offering extremely high resistance to abrasion.

**Hardness**

The resistance of a metal to plastic deformation usually by indentation.

**Hardness test**

A test by which the resistance to deformation is determined, usually by relating the load applied to an indenter of prescribed form to the depth or surface area of the impression produced.

**Heat treatable alloy**

An alloy capable of being strengthened by suitable heat treatment.

**Heat treatment**

The heating and cooling of a solid metal or alloy in such a way as to obtain desired conditions or properties. Heating for the sole purpose of hot working is excluded from the meaning of this term.



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### **Heat-treatment batch**

A quantity of material of one alloy of the same dimensions and produced in the same way, solution treated in one furnace load, or such material so solution treated and subsequently artificially aged in one furnace load. More than one heat-treatment batch may comprise a furnace load. In the aircraft sphere the material is normally from one cast.

### **Herring bone mark**

Superficial markings taking the form of alternate light and dark bands forming a V or W pattern across the width of strip-mill rolled material.

### **Holding time at temperature**

The duration of holding at the prescribed temperature, including the specified tolerance from the time when the coolest part of the metal attains the minimum specified temperature.

### **Hollow extrusion ingot**

An extrusion ingot with a central longitudinal hollow extrusion billet hole produced either at the casting stage or by machining a solid ingot.

### **Hollow section**

An extruded shape, other than round, the cross section of which completely encloses a void or voids and which is not subject to cold drawing.

### **Homogenization**

A process in which metal is heated at high temperature during a specified time generally in order to facilitate working and to confer certain desirable properties on the semi-fabricated product.

### **Hot line quenching / Hot mill quenching**

Cooling of a rolled product leaving the hot line or hot mill with the primary object of retaining soluble constituents in solid solution after quenching.

### **Hot rolled rod**

An approximately round section, normally of 9.5mm nominal diameter, produced by a hot rolling process.

### **Hot shortness**

Brittleness in metal in the hot forming range and also the characteristic of a metal that results in a loss of plasticity at or near the melting point.

### **Hot working**

Plastic deformation of a metal or alloy within a temperature range and at a rate such that significant strain hardening does not occur.

### **Immersion coating**

Chemical surface treatment in which other metals (zinc, tin, copper, lead, silver, Nickel) are deposited on aluminium by chemical displacement and serve as a substrate for subsequent electroplating or electroless plating.

### **Impact extrusion**

A process in which an unheated slug is extruded through a die by a single blow in the direction of the blow, or in the space between the punch and the closed die in the direction counter to the blow.

### **Impurities**

Metallic or non-metallic substances in a metal or alloy that were not intentionally added.

### **Inclusion**

Extraneous material accidentally entrapped within the metal during casting.





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**Incubation period**

The interval between the quenching operation and the start of a significant change in properties produced by precipitation hardening.

**Indirect extrusion**

A process whereby a moving die located at the end of a hollow ram is forced against a stationary ingot.

**Ingot**

A cast form suitable for remelting or billet fabricating.

**Integral colour anodizing**

Production of colour anodized finishes by the use of special alloys of aluminium and/or special organic electrolytes that produce a colour during anodizing.

**Integral test piece**

A tensile test sample produced integrally with the work-piece usually on forgings.

**Intercrystalline corrosion**

Corrosion occurring preferentially at grain intergranular corrosion boundaries.

**Interleaving**

The practice of protecting the surface of plate, sheet and strip by separating adjacent surfaces by suitable paper or plastics film.

**Internal stress**

Stresses set up within the material as a result of previous operations, e.g. casting, thermal treatment or fabrication.

**Irregular section**

A solid drawn or extruded section the profile of which cannot be divided readily into approximate rectangles of measurable dimensions.

**Isothermal quenching**

Quenching carried out in a medium at a temperature intermediate between the solution treatment temperature and room temperature, and at which the metal is held for a prescribed time to induce precipitation hardening.

**Kink**

An abrupt bend or departure from flatness.

**Laminated product**

Composite product consisting of two or more sheets or films joined together, e.g. paper to foil, plastics film to foil, etc.

**Lamination**

Internal crack aligned parallel to the principal surfaces of a sheet or plate.

**Lap**

An open-ended surface discontinuity formed as a result of metal folding over during mechanical working.

**Lateral curvature**

The lateral departure, in the form of an arc, edge curvature of an edge from straightness.

**Layer wound coil**

Wire wound layer on layer across the width of a spool, where the width of the coil is greater than the width of the material.



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**Length**

The dimension that lies in the direction of maximum working.

**Linishing**

Grinding with a coarse abrasive to remove scurfing superficial defects either to produce a decorative finish or preparatory to further processing.

**Liquidation**

Fusion of the lower-melting point constituents of an alloy during hot working or thermal treatment.

**Lock-seamed tube**

Tube formed from strip, the seam being mechanically locked.

**Long transverse direction**

The direction along the major axis at right angles to the longitudinal direction.

**Longitudinal direction**

The direction parallel to the principal elongation during working.

**Longitudinal properties**

The properties in the direction parallel to the principal elongation during working.

**Lower critical strain**

The minimum amount of cold work or cold deformation necessary to initiate recrystallization during subsequent annealing or solution heat treatment and which usually causes the growth of coarse grains.

**Luders lines**

Surface markings resulting from localized flow that appear on some alloys after light straining. They lie approximately parallel to the direction of maximum shear stress (about 45° to the direction of applied stress).

**Machining stock**

Bar or wire usually supplied to close tolerances and suitable for repetition machining operations.

**Mandrel**

A steel insert within the die orifice controlling the internal form of hollow products during extrusion, forging or drawing.

**Mass effect**

The effect of the size and shape of an article on the rate of heat transfer during quenching, resulting in variations in mechanical properties from the outside to the centre.

**Matching draft angle**

A draft angle greater than the natural draft angle necessitated on forgings unequally disposed about the flash line to provide coincident edges on that line.

**Matt finish**

A diffuse finish usually produced by etching, scratch brushing or blast cleaning.

**Mean diameter**

The sum of any two diameters at right angles divided by two.

**Mean wall thickness**

The sum of the wall thickness of tube measured at the ends of any two diameters at right angles, divided by four.



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**Mechanical polishing**

Polishing with an abrasive belt or flexible rotating mop carrying an abrasive buffing compound.

**Milling**

A machining process in which metal is removed by a revolving multi-edged cutter to provide flat or profile surfaces.

**Mirror finish**

A rolled or polished finish with high specular reflectivity.

**Mismatch**

The maximum lateral displacement of any point in that part of a forging formed by one die from its correct position relative to the part of the forging formed in the other die of the pair.

**Moulding**

Preliminary die-shaping prior to forging between closed dies.

**Moulding die**

A die that shapes the stock prior to forging preforming die between closed dies.

**Multi-hole die**

An extrusion die having more than one hole.

**Multi-hole die effect**

Non-concentric configuration of grain structure resulting from the use of multi-hole dies.

**Nail wire**

Alloy wire of high corrosion resistance suitable for the manufacture of nails.

**Natural ageing**

Increasing the hardness and strength of an alloy by spontaneous precipitation of constituents from a super-saturated solid solution at room temperature.

**Natural draft angle**

The minimum draft angle compatible with consistent freeing of the top die from the product during forging.

**Natural oxide film**

The film of aluminium oxide that forms naturally on aluminium and is relatively impervious to atmospheric attack. The thickness of this film and the protection it offers can be increased by Anodising.

**Non-heat treatable material**

An alloy incapable of being strengthened by thermal treatment.

**Oil staining**

Staining associated with the partial decomposition of residual lubricant during thermal treatment.

**Oilcan effect**

In sheet or strip, a localized departure from flatness that behaves in a similar manner to the diaphragm of an oilcan under alternating pressure.

**Orange peel effect**

Surface roughening on formed products resulting from the use of coarse grained material.

**Open die**

A forging die with a flat face, i.e. a die into which no impression has been cut.



## Aluminium Alloy - Glossary of Terms for Aluminium

**Ovality**

The departure of the cross section of a round tube, bar or wire from a true circle.

**Over-ageing**

Artificial ageing treatment at too high a temperature or for too long a period, resulting in slight softening of the metal after the maximum hardening effect has been achieved. In some cases this may be done deliberately, e.g. to improve resistance to stress corrosion.

**Overheating**

Modification of the structure of an alloy made evident by the fusion of certain constituents and by a reduction in mechanical properties. Overheated material cannot be reclaimed by thermal or mechanical treatment.

**Overstretching**

Stretching to such a degree that stretcher markings develop or the grain structure of the metal is revealed.

**Pack marks**

Small superficial marks associated with differential metal flow in pack rolling.

**Pack rolling**

The simultaneous rolling of two or more thicknesses of sheet, strip or foil.

**Pancake coil**

Narrow strip and flattened wire wound layer on layer where the width of the coil is equal to the width of the material.

**Partial annealing**

Thermal treatment of a cold worked metal or alloy to reduce the strength to a controlled, but not fully softened, level.

**Patterned sheet**

Sheet on which a raised or indented pattern has been impressed on either one or both faces.

**Patterned strip**

Strip on which a raised or indented pattern has been impressed on either one or both faces.

**Percentage elongation**

The elongation of the gauge length after fracture (A) fracture, expressed as a percentage of the original gauge length.

**Percentage reduction area**

The maximum change in cross-sectional area that has occurred divided by the original cross-sectional area, expressed as a percentage. In the tensile test the percentage reduction of area,  $Z$ , is the maximum change in cross-sectional area that has occurred during the test,  $S - S_f$ , divided by the original cross-sectional area,  $S_0$ , expressed as a percentage.  $S_f$  is the minimum cross-sectional area after fracture).

In extrusion the percentage reduction of area is the change of cross-sectional area that has occurred during the extrusion,  $S - s$ , divided by cross-sectional area before extrusion,  $S_0$ , expressed as a percentage. Here  $S$  relates to the cross section of the container.

**Peripheral coarse grain**

An area of recrystallized grains at the peripheral grain band periphery of an extruded product (or forged product if made from extruded stock), which has lower properties than the non-recrystallized core.

**Peripheral grain band**

See peripheral coarse grain.



## Aluminium Alloy - Glossary of Terms for Aluminium

**Pick-up**

Irregular surface roughness caused by intermittent adhesion between the forming tools and the metal.

**Piercing mandrel**

A mandrel attached to an auxiliary ram that pierces solid extrusion ingots and thereafter serves as an arrested mandrel.

**Pig**

Metal in a form suitable for remelting, cast directly from the extraction process without being subjected to any intermediate metallurgical processing.

**Pitting corrosion**

Localized corrosion resulting in small pits or craters in the metal surface.

**Plate**

A product of rectangular section over 6mm thick, supplied flat and with less control of surface finish than applies to sheet.

**Pointing**

Reducing one end of a rod, bar, tube or wire to tagging a size capable of passing through a drawing die.

**Porthole die**

An extrusion die that incorporates a mandrel as an integral part of the die assembly. Bridge, spider, duo and self-stripping dies are special forms of porthole die. These are used to produce extruded hollow products from solid extrusion ingots.

**Pre-ageing**

A short thermal treatment applied after quenching and before the end of the incubation period.

**Precipitation annealing**

Heating quenched and precipitation hardened metal for a sufficient length of time at a temperature between the artificial ageing temperature and the solution treatment temperature in order to produce a relatively high degree of softening by means of coalescing the hardening precipitates.

**Precision forging**

A die forging made to special tolerances.

**Preheating**

A process in which the workpiece is raised to the temperature required for entry to the first hot working operation. In some cases this may be combined with homogenization.

**Press**

A general term for a machine employing pressure to deform or shear metal.

**Press discard**

That portion of an extrusion ingot that is left unextruded.

**Press forging**

A die forging made on a mechanical or hydraulic press by one or more applications of sustained pressure.

**Press quenching**

Cooling of an extruded product leaving the die with the primary object of retaining soluble constituents in solid solution after quenching.





## Aluminium Alloy - Glossary of Terms for Aluminium

### **Pressing**

The shaping of sheet or forging stock between closed dies on a mechanical or hydraulic press.

### **Pressure test**

A hydraulic or pneumatic test applied to tube to ensure that the material will withstand a specified pressure for a specified time without unacceptable leakage or distortion.

### **Pretreatment priming**

The application of a solution containing a resin, a chromate and an acid, which is allowed to dry on and provide the key for subsequent painting.

### **Primary aluminium**

Metal extracted by reduction from, or by decomposition of, an aluminium compound, which has not been subjected to any fabricating other than casting into pigs or ingots. Scrap from the ingot producer's own operations, which arises directly from the casting or working of primary melts, may be incorporated in primary melts without modifying the character of primary melts, provided that the identity of the scrap metal is fully established and maintained, and that no metallic impurities foreign to the producer's primary unalloyed aluminium operation are a possible cause of contamination.

### **Priming**

The application of a priming paint, often pigmented with a corrosion inhibitor such as zinc chromate, after suitable pretreatment.

### **Printed foil**

Foil printed with a design or all-over colour.

### **Profile wire**

A solid section, other than round, square or regular polygonal, of 10mm maximum dimension, produced by a wire-drawing process. Typical sections are pinion, serrated, half-round and triangular.

### **Proof stress (Rp)**

The stress at which a non-proportional elongation equal to a specified percentage of the original gauge length occurs. When a proof stress is specified, the non-proportional elongation should be stated (e.g. 0.2% or 1%) and the symbol used for the stress should be supplemented by an index giving this prescribed percentage of the original gauge length, e.g. Rp0.2.

### **Protective anodizing**

Anodizing where protection against corrosion or wear is the primary object and appearance is of secondary or no importance.

### **Protective oiling**

The application of oil to products to provide temporary protection against atmospheric attack during transit and during storage.

### **Punching**

The removal of metal from rolled or extruded products by perforating or shearing on a press with a punching die.

### **Quenching**

A process of cooling a metal or alloy from an elevated temperature by contact with a solid, a liquid or a gas, at a rate rapid enough to retain some or all of the hardening constituents in solid solution. NOTE: See also as-quenched condition, critical quenching rate, isothermal quenching, quenching stress, self-quenching alloy.



## Aluminium Alloy - Glossary of Terms for Aluminium

**Quenching stress**

Non-uniform stress retained within the metal after quenching.

**Random lengths**

Cut pieces usually specified between wide limits of length.

**Recrystallization**

Formation of a new grain structure by the heating of cold worked material.

**Recrystallization annealing**

Thermal treatment to soften a cold worked metal or alloy by complete recrystallization.

**Rectification**

The correction of dimensional irregularities.

**Reeling**

The straightening of round bar, rod or tube by a rotary and flexing action by passing it through offset driven rollers.

**Reeling marks**

Superficial spiral markings present on round extruded or drawn products that have been straightened by reeling.

**Refined aluminium**

Metal of very high purity (conventional aluminium content 99.95% and more) that is obtained by special metallurgical treatments.

**Reflector sheet**

Rolled material with characteristics that make it especially suitable for the manufacture of anodized reflectors.

**Regular section**

A solid drawn or extruded section, not otherwise covered by the definition of a bar, that can be conveniently divided into approximate rectangles with measurable dimensions, e.g. angles, channels, tees, etc. The ratio of maximum thickness to minimum thickness of such regular sections does not exceed 4:1.

**Reheating**

Heating metal to hot working temperature. In general no structural changes are intended.

**Residual stress**

Such internal stress as may be left in the finished product after fabricating operations, including stress relieving (where applicable), have been carried out.

**Ripple**

A surface effect in the form of a very slight repeated transverse wave or shadow mark, sometimes encountered with rolled or drawn products.

**Rivet stock**

Round bar or wire suitable for the manufacture of rivets.

**Roll mark**

A defect on plate, sheet, strip or flattened wire, repeated at regular intervals and caused by an imperfection in the roll surface.

**Roll-bonded sheet**

A composite of two sheets pressure welded together during rolling except at predetermined areas that are subsequently inflated to form a labyrinth or passageway.



## Aluminium Alloy - Glossary of Terms for Aluminium

**Roller levelling**

The flattening of plate or sheet by passing it between a series of staggered rolls of small diameter.

**Roller straightening**

The straightening of an extrusion, other than round, by passing it through a series of staggered rolls of small diameter.

**Rolling ingot**

A solid rectangular casting used for rolling rolling block into plate, sheet, strip and foil. rolling slab

**Ruling thickness**

The dimension of a bar, forging or component across which the time of transfer is the longest in heat treatment operations.

**Satin finish**

A fine-textured matt finish.

**Satin-finish sheet**

Sheet having a fine-textured matt finish on one or both surfaces.

**Satin-finish strip**

Strip having a fine-textured matt finish on one or both surfaces.

**Scaffold tube**

Extruded tube of dimensions and strength suitable for scaffolding.

**Scalping**

The surface machining of extrusion ingot, forging stock, rolling ingot and wire bars (or of semi-finished wrought products) preparatory to their fabrication.

**Scratch-brushed finish**

A matt or satin finish produced by abrasion with rotating wire brushes.

**Screw stock**

Round bar or wire suitable for the manufacture of screws.

**Sealing of anodic coatings**

A treatment applied after anodizing to reduce porosity and/or absorptivity of the coating.

**Seamless tube**

Tube in which there is no split or deliberate longitudinal bonding of two or more edges by pressure, fusion or mechanical interlocking.

**Secondary aluminium**

Metal obtained by the recovery and treatment of metal that has been submitted to at least one fabricating process by casting or working and does not conform to the definition of primary or refined aluminium.

**Secondary aluminium alloy**

Alloy obtained by the recovery and treatment of metal that has been submitted to at least one fabricating process by casting or working.

**Segregation**

Non-uniform distribution or concentration of impurities or alloying constituents that arises during the solidification of an ingot.



## Aluminium Alloy - Glossary of Terms for Aluminium

**Self-quenching alloy**

An alloy that is relatively insensitive to cooling rate from solution heat treatment temperature, i.e. in which the critical quenching rate is normally less than the rate of cooling in still air.

**Semicontinuous casting**

A process in which the liquid metal is, solidified rapidly in a water-cooled mould or die and continuously withdrawn until the required length has been produced, when casting is discontinued.

**Shaped tube**

Drawn tube of a shape other than round.

**Shaving**

The drawing of hot rolled rod, tube or wire through a die with a cutting edge in order to remove a thin layer from its surface.

**Shear strength**

The maximum stress that the material is capable of sustaining in shear.

**Shear test**

A test in which the test piece is stressed in shear until fracture to determine its shear strength.

**Shearing**

The cutting of metal by the use of a press or guillotine.

**Sheet**

A rolled product of rectangular section over 0.2mm but not exceeding 6mm thick, supplied flat.

**Sheet mill**

A mill used for cold rolling either plate or sheet.

**Short transverse direction**

The direction along the minor axis at right angles to the longitudinal direction.

**Single-hole die**

An extrusion die having only one hole.

**Sinking**

The reduction of the outside diameter of tube sinking pass by pulling it through a die without using a draw plug or mandrel.

**Sintered aluminium powder**

A wrought product made from fine oxidized product aluminium powder by compacting, sintering, hot pressing and subsequent working.

**Skin pass**

A light cold rolling of sheet or strip to improve surface finish and to minimize stretcher strain on further manipulation. This operation may increase the elastic limit and to a lesser extent the tensile strength.

**Sliding fit**

The ability of two pieces of metal, one having internal and the other external bearing surfaces of complementary shape, to fit and move easily one within the other.

**Slitting**

The cutting of strip into two or more widths by the use of rotary shears.



## Aluminium Alloy - Glossary of Terms for Aluminium

**Sliver**

A thin elongated piece of the parent metal adhering imperfectly to the surface of a product.

**Slug**

A blank prepared for impact extrusion.

**Solution treatment**

A thermal treatment in which an alloy is heated to a suitable temperature, and is held at this temperature long enough to allow constituents to enter into solid solution and is then quenched.

**Speed cracking**

Transverse surface cracks produced by excessive speed cross hatching extrusion speed and/or extrusion emergence temperature.

**Spectrochemical Analysis**

Test performed to verify material chemistry

**Spinner straightening**

The automatic straightening and cutting to and cutting length of coiled wire by feeding it through a machine consisting of rotating offset dies in tandem with a pair of cropping dies.

**Split tube**

Tube formed from strip with an open seam.

**Spring back**

The partial elastic recovery of materials after cold deformation.

**Stabilization treatment**

Thermal treatment used to accelerate constitutional or structural changes in order to promote stability in dimensions, mechanical properties, structure or internal stress under service conditions.

**Stamping**

The shaping of sheet or forging stock between closed dies on a drop hammer.

**Step ageing**

Artificial ageing treatment carried out in successive stages at different temperatures.

**Stepped extrusion**

An extrusion having one or more abrupt changes in cross section along its length.

**Stop mark**

A transverse peripheral ridge on a product arising from a stoppage during rolling, extrusion or drawing.

**Straightening**

The removal of longitudinal distortion in a drawn or extruded product.

**Straightness**

The extent to which the axis or the edge of a product approaches to a straight line.

**Strain hardening**

Modification of a metal structure by working cold working at room temperature or moderate temperature work hardening resulting in an increase in strength and hardness with a general loss of ductility.





## Aluminium Alloy - Glossary of Terms for Aluminium

### **Stress corrosion**

Failure by cracking resulting from selective directional attack caused by simultaneous interaction of sustained tensile stress at an exposed surface with the chemical or electrochemical effects of a service environment.

### **Stress relieving**

The reduction of residual internal stresses by thermal or mechanical means.

### **Stretcher grip marks**

Transverse indentation at the ends of a product impressed by the grips of the stretching machine.

### **Stretcher strain markings**

Permanent surface distortion in the form of either flamboyant patterns or Luders lines that appear when materials are stretched. The onset of these markings varies according to the type of material and the degree of stretching.

### **Stretching**

The levelling of rolled materials or the straightening of extruded and drawn materials by imparting sufficient permanent extension to remove distortion. NOTE: See also overstretching.

### **Strip**

A cold rolled product of rectangular section supplied in coil, over 0.2mm but not exceeding 3mm thick.

### **Strip mill**

A mill with coiling equipment, employed for the cold rolling of strip.

### **Super annealing**

The annealing of heat treatable alloys, followed  
by a slow, controlled rate of cooling to produce  
a condition of maximum ductility with a minimum  
tendency to natural ageing.

### **Surface bloom**

Surface discoloration that may develop on  
aluminium during exposure to moist atmospheres  
or during thermal treatment.

### **Surface texture**

Those irregularities with regular or irregular  
spacing that tend to form a pattern or texture  
on the surface.

### **Swageing**

The reduction of the circular cross section of  
stock by a hammering or squeezing action.

### **Swageing die**

Forging dies used in pairs, through which stock is worked by a hammering action, the circular cross section of the material thereby being reduced.

### **Tapered extrusion**

An extrusion tapering continuously along its length.

### **Temper**

Characteristic structural and mechanical properties produced in a metal or alloy by transformation processes, e.g. mechanical and/or thermal treatments.



## Aluminium Alloy - Glossary of Terms for Aluminium

**Temper drawing**

Controlled reduction by drawing to develop the required mechanical properties.

**Temper rolling**

Controlled reduction by cold rolling to develop the required mechanical properties.

**Tensile strength (R )**

The maximum force divided by the original cross-sectional area of the test piece, i.e. nominal stress corresponding to the maximum force.

**Tensile test**

A test in which the test piece is stressed in tension, generally until fracture, to determine one or more of its tensile properties.

**Tension levelling**

A method of flattening strip continuously on a series of staggered rolls with applied tension, thus stretching the strip while bending it.

**Tolerance**

An allowable amount of deviation from a specified characteristic.

**Tonghold**

A projection of metal on a forging to facilitate manipulation during processing.

**Tonghold test piece**

A tensile test sample taken from the tonghold of a forging.

**Torsion test**

A test in which a sample is twisted axially for a given number of revolutions.

**Traffic marks**

Abrasions, usually dark in colour, resulting from relative movement between contacting metal surfaces during transit.

**Transfer period**

The time between removing the material from the solution treatment furnace and immersion in the quenching medium.

**Tread plate / Treadplate**

Plate upon which a raised or indented non-slip pattern has been impressed by rolling.

**Trimming**

The removal of excess metal from the edges of dressing a semifabricated product.

**Troughed type A corrugated**

Formed sheet of asymmetrical profile with wide sheet truncated-vee troughs.

**Trunnioning**

The expansion by rotary forging of a hollow round blank over a mandrel to increase the internal diameter with or without an increase in the external diameter.

**Tube**

A hollow wrought product that is long in relation to its cross section with a uniform wall thickness (except where corner radii are involved in shaped tube).



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**Tube bloom**

A circular hollow extrusion of uniform wall thickness used for the production of drawn tube.

**Tube reducing**

The production of tube from tube bloom by rolling on a mandrel.

**Tup**

The heavy moving portion of the drop stamp carrying the top die.

**Turks head die**

Four adjustable undriven rollers arranged mutually at right angles to serve as a die for the final shaping of solid and hollow sections, e.g. squares and rectangles.

**Twist**

Torsional deviation of the transverse axis along the length of a product.

**Ultrasonic Testing**

A method of non-destructive testing of solid metal for internal flaws utilizing high frequency sound waves.

**Under-ageing**

Artificial ageing treatment at too low a temperature and/or for too short a period resulting in a failure to attain the maximum hardening effect.

**Upper critical strain**

The minimum amount of cold work necessary to eliminate the cold work structure of elongated grain and produce a fine recrystallized grain during annealing or solution heat treatment.

**Upsetting**

A method of working forging stock in order to increase its cross-sectional area.

**Venetian blind strip**

Thin gauge strip specially produced with characteristics that make it suitable for the manufacture of venetian blind slats.

**Wavy edges**

Departure from flatness represented by a corrugated or wave-like formation of the edges of a rolled product in which the centre area remains flat.

**Welded tube**

Tube formed from plate, sheet or strip with the abutting edges automatically welded.

**Width**

The dimension that lies transverse to the direction of maximum working.

**Wire**

A round, square or regular polygonal solid section of not more than 10mm diameter or width across flats produced by drawing, usually supplied in coil.

**Wirebar**

A cast or extruded square or circular section used for the production of hot rolled rod and ultimately wire.

**Work hardening**

Modification of a metal structure by working cold working at room temperature or moderate temperatures strain hardening resulting in an increase in strength and hardness with a general loss of ductility.



## Aluminium Alloy - Glossary of Terms for Aluminium

**Working**

Deformation of a metal with general elongation but not necessarily in a preferred direction. Working may be carried out hot or cold by such processes as rolling, extruding, forging etc.

**Wrapping test**

The test consists of winding the wire a specified number of turns around the mandrel of the diameter stated in the material specification. It may also include a specified programme of unwinding or of unwinding and rewinding.

**Wrought product**

Product made by hot, or hot and cold, plastic deformation of a cast product, such as rolling, extruding, forging, etc.