

# **Global Advisory Group GAG - Guidance**

**GAG Guidance Document 001**

**Terms and Definitions**

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## Contents

<b>Introduction.....</b>	<b>3</b>
<b>1. Scope .....</b>	<b>3</b>
<b>2. Aluminium products.....</b>	<b>4</b>
2.1. Aluminium .....	4
2.2. Alloys, alloying elements and impurities.....	4
2.3. Materials and products .....	5
2.4. Unwrought products, excepting castings.....	6
2.5. Castings.....	6
2.6. Sheet and plate.....	7
2.7. Foil .....	9
2.8. Profiles and tubes .....	9
2.9. Rod, bar and wire .....	11
2.10. forgings and forging stock.....	12
<b>3. Technical and metallurgical processes, scrap and residues .....</b>	<b>13</b>
3.1. Casting and allied finishing operations .....	13
3.2. Forming and working, general terms .....	14
3.3. Rolling and finishing of rolled products.....	14
3.4. Extrusion, drawing and finishing of extruded/drawn products.....	15
3.5. Other forming operations .....	16
3.6. Thermal treatment .....	17
3.7. Solution heat treatment, quenching and ageing.....	18
3.8. Electrochemical and chemical treatment.....	19
3.9. Coating .....	20
3.10. Mechanical surface treatment and surface finish .....	21
3.11. Marking, packaging and delivery .....	22
3.12. Aluminium scrap and recycling operations .....	23
3.13. Residues of the aluminium industry .....	25
<b>4. Sampling, testing and product characteristics .....</b>	<b>27</b>
4.1. Sampling and preparation of test-pieces .....	27
4.2. Tests .....	28
4.3. Mechanical properties.....	29
4.4. Product characteristics on form and dimensions.....	31
4.5. Physical and metallurgical product characteristics.....	33
<b>5. Visual quality characteristics .....</b>	<b>34</b>
5.1. General terms .....	34
5.2. Typical terms for ingots and castings .....	34
5.3. Visual quality characteristics related to form and dimension.....	35
5.4. Visible surface quality characteristics on wrought products, mainly mechanical .....	37
5.5. Visible quality characteristics of wrought products, mainly metallurgical .....	39
5.6. Discolorations, oil/dirt, stains and corrosion .....	40
5.7. Visible quality characteristics of coated and clad products .....	41
5.8. Typical terms for extruded products and forgings .....	42
5.9. Typical terms for foil and formed products .....	43
<b>6. Glossary .....</b>	<b>44</b>
<b>Copyright.....</b>	<b>49</b>
<b>Disclaimer .....</b>	<b>49</b>

## Introduction

The market of many aluminium products is global and involves a global communication between the stakeholders, e.g. suppliers and purchasers. They are often of different native language, but mostly use the English language for their correspondence.

The aluminium industry uses a lot of technical terms which cannot be found in dictionaries. Some of them are collected in European or North American standards. But often they are used for different concepts, which may cause misunderstandings.

This Global Guidance Document has been prepared by the GAG/WG 01 "Terms and Definitions". It tries to improve communication in the international trade and by this intends to contribute to the elimination of trade barriers. Especially, it is intended to be a source for terms and definitions to be used in standards. By using identical terms and definitions, as far as possible, in standards of different countries or continents, a better alignment of such standards is possible.

The terms in this document are grouped in different clauses dealing with products, processing, sampling and testing, product characteristics and different types of non-conformities. It has been decided to include all these terms into one document, because it is assumed that the document will mainly be used in electronic form and search systems are used in order to find the relevant terms. In addition, an alphabetical register at the end of the document gives further guidance.

### 1. Scope

This Document defines general terms which are helpful for the communication within the aluminium industry and its customers relating to products of aluminium and aluminium alloys. It includes terms dealing with aluminium products, scrap and waste, processing, sampling and testing, product characteristics and different types of visual quality characteristics.

It does not include terms dealing with bauxite mining, alumina and anode production and aluminium smelting.

If other definitions of a term in this document appear in other documents, then these different definitions apply for the scope of this other document.

This Global Guidance Document tries to be as close as possible to terms and definitions as used in other standards or legal documents. If another definition of a term in this document appears in another document, then this different definition applies for the scope of this other document.

NOTE: For materials other than aluminium different definitions can apply for terms which are defined in this document.

This Global Guidance Document tries to follow the "common language" as used in native English speaking countries, without giving preference to specific idioms of one of these countries. In cases where in different English-speaking countries different terms are used for the same concept or different concepts refer to an identical term, it gives the appropriate explanations. It does not urge specific regions to use global terms or orthographic spellings as defined in this document for local purposes. As an example, this document does not require to use the term "aluminium" instead of "aluminum" in documents where the audience is located in the USA. It is also understood that the definitions in this document may be translated into other languages, but we can provide no assurance as to the accuracy of such translations. English is the originating language for all definitions in this document.

This document is a revision of GAG Terms and Definitions 2009-01. Changes from the earlier edition are indicated as follows:

‡ - Indicates an added term.

† - Indicates a term that has been revised.

## 2. Aluminium products

### 2.1. Aluminium

#### 2.1.1. aluminium

unalloyed aluminium or aluminium alloy

NOTE: In the USA the term "aluminum" is used.

#### 2.1.2. unalloyed aluminium

aluminium without alloying elements where the minimum aluminium content is specified to be greater than 99,00%

NOTE: Unalloyed aluminium is often called "aluminium", i.e. the term "aluminium" then does not include aluminium alloys.

#### 2.1.3. refined aluminium

unalloyed aluminium of high purity (aluminium content of at least: 99,950% by mass) obtained by special metallurgical treatments

#### 2.1.4. primary aluminium

Unalloyed aluminium produced from alumina, typically by electrolysis, and with an aluminium content of 99,7%.

## 2.2. Alloys, alloying elements and impurities

### 2.2.1. alloy

substance having metallic properties and composed of two or more elements, so combined that they cannot readily be separated by physical means

#### 2.2.2. aluminium alloy

aluminium which contains alloying elements, where aluminium predominates by mass over each of the other elements and where the aluminium content is not greater than 99,00%

#### 2.2.3. alloying element

metallic or non-metallic element which is controlled within specific upper and lower limits for the purpose of giving the aluminium alloy certain special properties

#### 2.2.4. impurity

metallic or non-metallic element present in a metal, the minimum content of which is not controlled

NOTE: Typically, the maximum concentration of an impurity in aluminium is controlled.

#### 2.2.5. casting alloy

alloy primarily intended for the production of castings

#### 2.2.6. refined aluminium alloy

casting alloy obtained after metallurgical treatment of molten metal obtained from aluminium scrap

#### 2.2.7. wrought alloy

alloy primarily intended for the production of wrought products by hot and/or cold working

#### 2.2.8. heat-treatable alloy

alloy which can be strengthened by suitable thermal treatment

#### 2.2.9. non-heat-treatable alloy

alloy which is primarily strengthened only by working and not by thermal treatment

#### 2.2.10. free machining alloy

alloy that, by virtue of its chemical composition and temper, is designed to give, on machining, small broken chips, typically by adding alloying elements with low melting point

#### 2.2.11. hardener

alloy containing at least some aluminium and one or more additional elements intended to be added to molten aluminium to adjust the chemical composition and /or to control the as cast structure.

NOTE 1: The term "master alloy" is used for different concepts in different reasons and should be avoided.

In Europe the term refers to hardeners obtained from melting and in the US the term refers to a hardener which combines several metallic elements in a fixed ratio and which is intended to be added to pure aluminium to provide a finished alloy composition.

NOTE 2: Hardeners can have various forms including waffles (obtained by casting the melt into an adequate mould), briquettes (obtained by compacting a powder), granules and wire.

**2.2.12. grain refiner**

hardener intended to refine the grain structure of cast aluminium

**2.2.13. modifier**

hardener intended to refine the microstructure of the alloy to which it is added

NOTE: An example of a modifier is 15% Sr.

**2.2.14. performance hardener; performance product**

hardener, not intended to adjust the chemical composition, but intended to improve alloy characteristics different from those achieved by grain refiners or modifiers

NOTE: Examples of performance hardeners include 20% Ca and 10% B.

**2.3. Materials and products**

**2.3.1. unwrought product**

product obtained by casting without further hot or cold working, e.g. ingots for rolling, ingots for extruding, ingots for forging, ingots for remelting, cast plate or castings

**2.3.2. wrought product**

product that has been subjected to hot working and/or cold working

**2.3.3. semi-finished product †**

product that has undergone some processing and is supplied for further processing before it is ready for use

NOTE: Semi-finished products include wrought products and castings. It does not include ingots and billets.

**2.3.4. drawn product**

product formed by pulling material through a die

**2.3.5. laminated material**

composite material obtained by joining layers of different materials together by means other than metallic bonding, typically by gluing them together

NOTE 1: Examples of laminated materials are paper on aluminium foil, extruded plastics films on aluminium foil, etc.

NOTE 2: Laminated material with a plastic core and aluminium skin on both sides is called "aluminium composite material (ACM)".

**2.3.6. matrix**

solid phase in which other constituents of the alloy are embedded as separate phases

**2.3.7. slug**

piece of metal of uniform thickness, of regular or irregular shape taken from a wrought product, typically for impact extrusion, with or without a centre hole

NOTE: This term is also used for cast or thycast pieces to be formed in semi-solid condition (thyxoforming).

**2.3.8. blank**

piece of metal of uniform thickness and of regular or irregular shape taken from a wrought or unwrought product

**2.3.9. flake**

flat or scale-like metal particles the thickness of which is small compared with the other dimensions

NOTE 1: Hardeners in the form of flakes are also called "splatters".

NOTE 2: In product specifications or safety instructions this term is typically defined more precisely.

**2.3.10. granules**

metal particles of tear drop-like shape, typically of more than about 1 mm in diameter, obtained by solidification of aluminium drops

NOTE: In product specifications or safety instructions this term is typically defined more precisely.

**2.3.11. aluminium powder**

aggregate of discrete metal particles in specified size ranges, typically below 0,15 mm in diameter

NOTE 1: In product specifications or safety instructions this term is typically defined more precisely.

NOTE 2: Aluminium powder is typically produced by atomizing and ball-milling.

**2.3.12. grit**

aggregate of discrete metal particles, coarser than aluminium powder, in specified size ranges typically below 3 mm in diameter

NOTE 1: In product specifications or safety instructions this term is typically defined more precisely.

NOTE 2: Grit is typically produced by milling, grinding or crushing.

### **2.3.13. aluminium powder product**

product obtained from fine aluminium powder by compacting and sintering, often followed by hot pressing and/or subsequent working; the product is characterized by a composition or structure which is difficult or impossible to obtain via casting

## **2.4. Unwrought products, excepting castings**

### **2.4.1. ingot**

cast product intended and suitable for remelting or forming by hot or cold working

### **2.4.2. primary aluminium ingot**

ingot of unalloyed or alloyed aluminium cast from primary aluminium and possibly a small amount of run-around scrap

### **2.4.3. recycled aluminium ingot**

aluminium ingot obtained by recycling of scrap

NOTE 1: The term "secondary aluminium" should be avoided for this concept.

NOTE 2: The terms "recycled aluminium strip", "recycled aluminium casting", "recycled aluminium profile" are defined accordingly.

### **2.4.4. ingot for remelting; remelt ingot**

ingot intended and suitable for remelting

NOTE 1: Large ingots for remelting, typically having a mass of about 500 kg, are often called "sows".

NOTE 2: Small ingots for remelting, typically having a mass of less than 25 kg, are often called "pigs".

### **2.4.5. ingot for casting**

ingot for remelting intended and suitable for the production of castings

### **2.4.6. extrusion ingot**

ingot, intended and suitable for extruding, typically of solid circular cross-section, sometimes with a central hollow or a flattened cross-section

### **2.4.7. extrusion billet**

extrusion ingot cut to length

### **2.4.8. extrusion log**

extrusion ingot not cut to length

### **2.4.9. forging ingot**

ingot intended and suitable for forging

### **2.4.10. rolling ingot**

ingot intended or suitable for rolling

### **2.4.11. head (of an ingot)**

end of a semi-continuously cast ingot corresponding to the end of the cast

NOTE: This term can refer to the removed head or the relevant extremity of the ingot.

### **2.4.12. butt (of an ingot)**

end of a semi-continuously cast ingot corresponding to the start of the cast

NOTE: This term can refer to the removed butt or the relevant extremity of the ingot.

### **2.4.13. edge (of a rolling ingot)**

one of the narrow faces (plane or of a specific geometry) of a rolling ingot parallel to the casting axis

### **2.4.14. rolling face (of a rolling ingot)**

wide face of a rolling ingot

## **2.5. Castings**

### **2.5.1. casting**

product at or near finished shape, formed by solidification of the metal in a mould or a die

### **2.5.2. sand casting**

casting produced by pouring molten metal into a sand mould and allowing it to solidify

### **2.5.3. permanent mould casting**

casting produced by introducing molten metal by gravity or low pressure into a mould constructed of durable material, typically iron or steel, and allowing it to solidify

NOTE: permanent mould casting where the metal solidifies in a metal mould under low pressure (typically less than 1 bar above atmospheric pressure) is also referred to as "low pressure die casting".

#### **2.5.4. semi-permanent mould casting**

permanent mould casting which is made using an expendable core such as sand

#### **2.5.5. die casting**

casting produced by introducing molten metal under substantial pressure, typically above 100 bars into a metal die and characterized by a high degree of fidelity to the die cavity

NOTE: The term "pressure die casting" or "high pressure die casting" is often used for this concept.

#### **2.5.6. precision casting**

casting which fulfils special requirements concerning tolerances on form and dimensions

NOTE: Precision castings can be produced by different casting processes.

#### **2.5.7. investment casting**

precision casting formed by a three step process comprising:

- a) fabrication of a ceramic mould around a wax or thermoplastic pattern with a refractory slurry that sets at room temperature;
- b) removal of the pattern through the use of heat;
- c) pouring of metal into this mould and allowing it to solidify

### **2.6. Sheet and plate**

#### **2.6.1. sheet**

rolled product that is rectangular in cross section with nominal thickness less than 6 mm (in USA less than 0.250 inches [6.3 mm]) but not less than 0,20 mm (in USA greater than 0.006 inches [0.15 mm]) and with slit, sheared or sawed edges

NOTE 1: A sheet can be supplied in a corrugated, embossed, coated, edge conditioned or perforated form.

NOTE 2: Sheet between 3 mm and 6 mm is sometimes called "shate".

NOTE 3: In Europe, the term "sheet" is only used for rolled products supplied in straight length, for coiled sheet the term "strip" is used.

NOTE 4: In the USA there is an overlap in the thickness range 0.006-0.0079 inch (0.15-0.20 mm) defined for foil and sheet. Sheet products in this gage range are supplied to sheet product specifications.

#### **2.6.2. coiled sheet**

sheet in coils with slit edges

#### **2.6.3. plate**

rolled product that is rectangular in cross section and with thickness not less than 6 mm (in USA not less than 0.250 inch) with sheared or sawn edges

#### **2.6.4. hot rolled sheet/hot rolled plate**

sheet or plate the final thickness of which is obtained by hot rolling

NOTE: A reroll plate is often called "slab".

#### **2.6.5. cold rolled sheet/cold rolled plate**

sheet or plate the final thickness of which is obtained by cold rolling

#### **2.6.6. reroll stock**

coiled sheet suitable and intended for further rolling

#### **2.6.7. anodising sheet**

sheet with metallurgical characteristics and surface quality suitable for the development of protective and decorative films by anodic oxidation processes

#### **2.6.8. brazing sheet**

sheet of a low melting point alloy or clad with a low melting point alloy, used for brazing

#### **2.6.9. can stock**

sheet or strip used for the fabrication of rigid cans including ends (lids) and tabs by drawing/ironing, pressing or forming operations. Can stock covers can body stock, end (lid) stock and tab stock

#### **2.6.10. circle stock**

sheet, strip or plate intended to be sawn, sheared or blanked into circles to be subsequently formed, drawn, etc.

#### **2.6.11. foil stock**

reroll stock suitable for further rolling to foil

**2.6.12. fin stock**

coiled sheet or foil suitable and intended for manufacture of fins for heat-exchanger applications

**2.6.13. lithographic sheet**

sheet having a superior finish on one side with respect to freedom from surface imperfections and supplied with a maximum degree of flatness for use as a plate in offset printing

**2.6.14. reflector sheet**

sheet with special requirements related to the surface quality intended and suitable for the manufacture of reflectors

**2.6.15. roofing sheet**

sheet intended and suitable for roofing application

**2.6.16. tooling plate**

cast or rolled product of rectangular cross-section over 6 mm (in USA 0.250 inches) in thickness, and with edges either as-cast, sheared or sawn, with internal stress levels controlled to achieve maximum stability for machining purposes in tool and jig applications

**2.6.17. master coil, parent coil**

coil processed to final temper as a single unit, intended to be slit and/or cut into smaller coils or into individual sheets or plates

NOTE: In North America the term "parent coil" is preferred for this concept.

**2.6.18. master plate, parent plate**

plate processed to final temper as a single unit, intended to be cut into smaller plates

**2.6.19. top side (of a sheet)**

the side of the strip with the higher surface finish requirements

NOTE 1: For coiled sheet the top side is normally the outside of the coil.

NOTE 2: For sheet supplied in stacks the top side is typically uppermost.

**2.6.20. reverse side (of a sheet)**

the side of the sheet which is opposite to the top side

**2.6.21. painted sheet**

sheet, one or both sides of which has a factory-applied paint coating of controlled thickness

**2.6.22. mill finish sheet/plate**

sheet/plate having a finish defined by the actual roll grinding and rolling conditions, without further specification from a customer or a standard

NOTE: The finish of mill finish sheet/plate can vary from sheet to sheet or within one sheet.

**2.6.23. one side bright mill finish sheet**

sheet having a moderate degree of brightness on one side and a mill finish on the other

**2.6.24. satin-finish sheet**

sheet with a fine-textured matte finish on one or both surfaces

**2.6.25. clad sheet/clad plate**

sheet or plate consisting of an aluminium core to which a thin layer of aluminium or another metal is metallurgically bonded on one side or on both sides, typically by rolling

**2.6.26. Alclad sheet/Alclad plate**

clad sheet/plate having on one or both surfaces a metallurgically bonded aluminium coating that is anodic to the core, thus electrolytically protecting the core against corrosion

NOTE: If one side only is clad, the product is often named "Alclad one side sheet/plate".

**2.6.27. flat sheet**

sheet with sheared, slit or sawed edges, which has been flattened or levelled

**2.6.28. corrugated sheet, profiled sheet**

roll-formed sheet of symmetric or asymmetric profile

**2.6.29. patterned sheet; embossed sheet**

sheet on which a raised or indented pattern has been impressed or embossed on either one or both faces

**2.6.30. tread plate**

sheet or plate upon which a pattern has been impressed on one side by rolling using a specially prepared roll with an appropriate pattern, to provide improved traction

**2.6.31. machined plate**

semi-finished product produced from a plate completely machined over one or two sides

**2.6.32. blank**

piece of metal of regular or irregular shape taken from a flat wrought product intended for subsequent processing such as bending, stamping or deep drawing

**2.6.33. circle**

circular blank fabricated from plate, sheet, or foil

**2.6.34. disc**

circle from which a central concentric area has been removed

**2.7. Foil**

**2.7.1. foil**

flat rolled product of rectangular cross-section with uniform thickness equal to or less than 0,20 mm (200 microns)

NOTE 1: In USA the maximum thickness of a foil is 0.0079 inch (formerly  $\leq$  0.006 in [0.15 mm]).

NOTE 2: In the USA there is an overlap in the thickness range 0.006-0.0079 inch [0.15-0.20 mm] defined for foil and sheet. Foil products in this gage range are supplied to foil product specifications.

**2.7.2. converter foil**

foil, typically soft annealed, supplied for further processing such as colouring, printing, embossing or laminating

**2.7.3. container foil**

single rolled foil with a gauge above approximately 35  $\mu$ m, produced at soft or intermediate temper and often involving alloys of the 3xxx and 8xxx series intended for press forming into smooth or wrinkled walled containers for foodstuffs and the like

**2.7.4. consumer foil; household foil**

foil intended for public use, principally for use in culinary applications such as cooking and storage

**2.7.5. printed foil**

foil printed with a design or on all-over colour

**2.7.6. embossed foil; patterned foil**

foil on which a pattern has been impressed or embossed on either one or both faces

**2.7.7. annealed foil**

foil completely softened by thermal treatment

**2.7.8. chemically cleaned foil**

foil washed in a chemical solution to remove lubricants and other foreign material

**2.7.9. etched foil**

foil roughened chemically or electrochemically to provide an increased surface area

**2.7.10. hard foil**

foil fully work-hardened by rolling

**2.7.11. intermediate temper foil**

foil manufactured in an undetermined temper between "annealed" and "hard"

**2.7.12. matte one side foil, pack rolled foil**

foil with a diffuse reflecting finish on one side and a bright specular finish on the other

**2.7.13. bright two-side foil**

foil having a uniform bright specular finish on both sides

**2.7.14. mechanically grained foil**

foil mechanically roughened for such applications as lithography

**2.7.15. mill finish foil**

foil having a non-uniform finish which may vary from coil to coil and within a coil

**2.8. Profiles and tubes**

**2.8.1. profile**

wrought product that is long in relation to its cross-sectional dimensions which is of a form other than that of sheet, plate, rod, bar, tube, wire or foil

NOTE: For profiles sometimes the term "shape" or "section" is used.

**2.8.2. extrudate**

material exiting an extrusion die subject to further processing (quenching, stretching, cutting), to become an extruded profile

**2.8.3. extruded profile**

profile brought to final dimensions by extruding

**2.8.4. cold-finished profile**

profile brought to final dimensions by cold-working to obtain improved surface finish and dimensional tolerances

**2.8.5. drawn profile**

cold-finished profile brought to final dimensions by drawing through a die

**2.8.6. solid profile**

profile in which the cross-section does not include any enclosed void

**2.8.7. hollow profile**

profile in which the cross section completely encloses one or more voids

**2.8.8. semi-hollow profile**

solid profile any part of whose cross section is a partially enclosed void the area of which is substantially greater than the square of the width of the gap

NOTE: The ratio of the area of the void to the square of the gap is dependent on the class of semi-hollow profile, the alloy and the gap width.

**2.8.9. seamless profile**

hollow profile which does not contain any line junctures resulting from method of manufacture

**2.8.10. precision profile**

profile which fulfils special requirements concerning tolerances on form and dimensions

**2.8.11. structural profile**

profile, rolled or extruded, commonly used for structural purposes such as angles, channels, H-beams, I-beams, tees, and zees

**2.8.12. tube**

hollow wrought product of uniform cross-section with only one enclosed void and with a uniform wall thickness, supplied in straight lengths or in coiled form; cross-sections are in the shape of circles, ovals, squares, rectangles, equilateral triangles or regular polygons and can have corners rounded, provided the inner and outer cross-sections are concentric and have the same form and orientation

NOTE: Tubes can be formed by extrusion or by forming and joining of sheet.

**2.8.13. extruded tube**

tube brought to final dimensions by extruding

**2.8.14. drawn tube**

tube brought to final dimensions by drawing through a die

**2.8.15. sized tube**

tube that, after extrusion, has been cold drawn a slight amount to minimize ovality

**2.8.16. porthole tube/bridge tube**

tube produced by extrusion of a solid billet through a porthole or bridge die

NOTE: The product is characterised by one or more longitudinal extrusion seams

**2.8.17. seamless tube**

tube which does not contain any line junctures resulting from method of manufacture

**2.8.18. welded tube**

tube produced by longitudinal seam-welding, typically of formed sheet

NOTE: Welded tubes can be fabricated by arc-welding with or without welding wire, high frequency seam welding, or any other type of welding.

**2.8.19. tube stock**

semi-finished tube suitable for the production of drawn tube

NOTE: Tube stock is also referred to as tube bloom.

**2.8.20. alclad tube**

composite tube composed of an aluminium alloy core having on either the inside or outside surface a metallurgically bonded aluminium coating that is anodic to the core, thus electrolytically protecting the core against corrosion

**2.8.21. embossed tube**

tube the outside surface of which has been roll-embossed with a design in relief regularly repeated in a longitudinal direction

**2.8.22. heat exchanger tube**

tube used in apparatus in which fluid inside the tube will be heated or cooled by fluid outside the tube, but the term is typically not applied to coiled tube or to tube for use in refrigerators or radiators

**2.8.23. structural tube**

tube commonly used for structural purposes

**2.8.24. pipe**

tube in standardized combinations of outside diameter and wall thickness

NOTE: Pipe is commonly designated by "Nominal Pipe Sizes" and "ANSI Schedule Numbers".

**2.8.25. back-end defect ‡**

cone-shaped defect resulting from surface contaminations and oxides being built up in front of the advancing extrusion pad due to container friction resulting in annular separation in the rear of the extrusion

## **2.9. Rod, bar and wire**

**2.9.1. rod**

solid wrought product of circular cross section that is long in relation to its diameter, typically supplied in straight length

NOTE 1: In North America, the minimum diameter of a rod is 0.375 inches (greater than 10 mm); below this limit, the product is called "wire".

NOTE 2: In Europe, a rod is supplied in straight length; if supplied in coiled form, the product is called "wire".

NOTE 3: In Europe, a rod is often called "round bar".

**2.9.2. bar**

solid wrought product that is long in relation to its cross-section which is square or rectangular (excluding plate and flattened wire) with sharp or rounded corners or edges, or is a regular hexagon or octagon, typically supplied in straight length

NOTE 1: In North America, the minimum perpendicular distance between at least one set of parallel faces of a bar is 0.375 inches (greater than 10 mm); below this limit the product is called "wire".

NOTE 2: In Europe, a bar is supplied in straight length; if supplied in coiled form, the product is called "wire".

**2.9.3. extruded rod**

rod brought to final dimensions by extruding

**2.9.4. extruded bar**

bar brought to final dimensions by extruding

**2.9.5. cold-finished bar**

bar brought to final dimensions by cold work to obtain improved surface finish and dimensional tolerances

NOTE: Typically cold finished bars are obtained by drawing.

**2.9.6. cold-drawn rod**

rod brought to final dimensions by cold-drawing through a die

**2.9.7. cold-drawn bar**

bar brought to final dimensions by cold-drawing through a die

**2.9.8. rolled rod**

rod brought to final dimensions by hot rolling

**2.9.9. rolled bar**

bar brought to final dimensions by hot rolling

**2.9.10. brazing rod**

rod of a low melting temperature alloy for use as filler metal in brazing

**2.9.11. welding rod**

rod for use as filler metal in joining by welding

**2.9.12. square bar**

bar of a square cross-section

**2.9.13. rectangular bar**

bar of a rectangular cross-section

NOTE: The term "rectangular rod/bar" includes "flattened circles" and "modified rectangles" of which two opposite sides are convex arcs, the other two sides being straight, of equal length and parallel.

**2.9.14. hexagonal bar**

bar having the cross-section of a regular hexagon

**2.9.15. bus bar**

rigid electric conductor in the form of a bar

NOTE: A rigid electric conductor of any cross-section is often called "bus conductor".

**2.9.16. wire**

solid wrought product that is long in relation to its cross-section, which is square or rectangular with sharp or rounded corners or edges, or is round, hexagonal, or octagonal

NOTE 1: In North America, the maximum diameter or perpendicular distance between parallel faces of a wire is less than 0.375 inches (up through 10.00 mm); above this limit the product is called "rod" or "bar".

NOTE 2: In Europe, a wire is supplied in coiled form; if supplied in straight length, the product is called "rod" or "bar".

**2.9.17. drawn wire**

wire brought to final dimension by drawing through a die

**2.9.18. extruded wire**

wire brought to final dimensions by extruding

**2.9.19. flattened wire**

wire having two parallel flat surfaces and rounded edges, typically produced by roll-flattening round wire

**2.9.20. drawing stock**

semi-finished solid wrought product of uniform cross section along its whole length, supplied in coils and of a quality intended and suitable for drawing into wire

**2.9.21. conductor wire**

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

**2.9.22. brazing wire**

wire of a low melting temperature alloy for use as filler metal in brazing

**2.9.23. welding wire**

wire for use as filler metal in joining by welding

**2.9.24. alclad wire**

composite wire product comprised of an aluminium alloy wire having on its surface a metallurgically bonded aluminium or aluminium alloy coating that is anodic to the alloy to which it is bonded, thus electrolytically protecting the core against corrosion

**2.9.25. machining stock**

bar or wire typically supplied to close tolerances and suitable for repetition machining operations

NOTE: This product is sometimes referred to as "screw machine stock" (SMS).

**2.9.26. bolt stock**

bar or wire suitable and intended for the manufacture of bolts

NOTE: The terms "cold heading rod" or "cold heading bar" are often used for this concept.

**2.9.27. rivet stock**

bar or wire suitable for the manufacture of rivets

NOTE: The terms "cold heading rod" or "cold heading bar" are often used for this concept.

**2.9.28. screw stock**

bar or wire suitable for the manufacture of screws

**2.10. Forgings and forging stock**

**2.10.1. forging**

wrought product formed by hammering or pressing, typically when hot, between open dies (hand forging) or closed dies (drop or die forging)

**2.10.2. die forging**

forging shaped by working in closed dies

**2.10.3. hand forging**

forging worked between flat or simply shaped dies by repeated strokes or blows and manipulation of the piece, intending to convert the metallurgical structure from cast to wrought prior to machining into a final part

**2.10.4. precision forging**

forging produced to tolerances closer than standard

**2.10.5. drop forging**

forging formed by a heavy die which drops on the metal

**2.10.6. hammer forging**

forging produced by repeated blows of a forging hammer

**2.10.7. rolled ring forging**

cylindrical product of relatively short height, circumferentially rolled from a hollow section

**2.10.8. blocker-type forging**

forging made in a single set of impressions to the general contour of a finished part

**2.10.9. cold-coined forging**

forging that has been restruck cold in order to obtain closer dimensions, to sharpen corners or outlines and in non-heat-treatable alloys, to increase hardness

**2.10.10. impact**

part formed in a confining die from a metal slug, typically cold, by rapid single stroke application of force through a punch, causing the metal to flow around the punch and/or through an opening in the punch or die

**2.10.11. forging stock**

solid product, typically ingot, rod, bar or profile, intended and suitable for forging

NOTE: Forging stock is typically a cast product or an extruded product

### **3. Technical and metallurgical processes, scrap and residues**

#### **3.1. Casting and allied finishing operations**

**3.1.1. casting process**

process in which molten metal is introduced into a mould where it solidifies

**3.1.2. direct chill (DC) casting**

casting process in which molten metal is solidified in a water-cooled open-ended mould from the outlet of which water is directly applied to the emerging ingot

**3.1.3. continuous casting**

casting process in which molten metal is solidified rapidly in a cooled mould and continuously withdrawn and cut while the mould is being simultaneously replenished with liquid metal

**3.1.4. rod casting**

continuous casting with subsequent in-line-rolling to wire, drawing stock or coiled profile

**3.1.5. strip casting**

continuous casting with subsequent in-line-coiling to strip, sometimes after one or several rolling passes

**3.1.6. semi-continuous casting**

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

**3.1.7. scalping**

removal of the surface layer from an ingot or a semi-finished wrought product so that surface imperfections will not be worked into the finished product

**3.1.8. sand casting process**

casting process in which molten metal is poured into a sand mould and solidified

**3.1.9. permanent mould casting process; chill casting process**

casting process in which molten metal is introduced by gravity or low pressure into a mould constructed of durable material, typically iron or steel

NOTE: A permanent mould casting process where the metal solidifies in a metal mould under low pressure (typically less than 1 bar above atmospheric pressure) is also referred to as "low pressure die casting process".

**3.1.10. die casting process**

casting process in which molten metal is introduced under substantial pressure, typically above 100 bars into a metal die

NOTE: Also referred to as "pressure die casting (process)" or "high pressure die casting (process)".

**3.1.11. investment casting process**

casting process of separate steps comprising:

- a) fabrication of a ceramic mould around a wax or thermoplastic pattern with a refractory slurry that sets at room temperature
- b) removal of the pattern through the use of heat
- c) pouring of metal into this mould and allowing it to solidify

**3.2. Forming and working, general terms**

**3.2.1. forming**

process by which a metal is transformed into a desired shape without changing its mass

**3.2.2. working**

forming of solid metal

**3.2.3. hot working**

forming of a solid metal after preheating

NOTE: Strain hardening may or may not occur during hot working.

**3.2.4. cold working**

forming of a solid metal without preheating

**3.2.5. thermo-mechanical processing**

combination of hot or cold working and heat treatment

**3.2.6. drawing**

pulling metal through a die in order to reduce or change the cross-section or to work harden the metal

NOTE: In forging, this term describes the process of working metal between flat dies to reduce the cross section and increase length.

**3.2.7. stretching**

imparting sufficient permanent set by applying a unidirectional force to cause strain hardening and reduce internal stress and distortion.

NOTE: Examples include flattening of rolled metal and straightening of extruded or extruded and drawn metal."

**3.2.8. stress relieving**

reduction of internal residual stresses by thermal or mechanical means

**3.2.9. strain**

measure of the change in size or shape of a body due to stress, relative to its original size or shape

NOTE: Tensile or compressive strain is the change, due to force, per unity of length in an original linear dimension in the direction of the force. It is typically measured in percent.

**3.2.10. permanent set**

strain remaining after complete release of the force producing the strain

**3.2.11. strain hardening**

modification of a metal structure by cold working resulting in an increase in strength and hardness, generally with loss of ductility

**3.2.12. stress**

force per unit of area. Stress is normally calculated on the basis of the original cross-sectional dimensions. The three kinds of stresses are tensile, compressive, and shear

**3.3. Rolling and finishing of rolled products**

**3.3.1. rolling**

forming of solid metal in a gap between two rotating cylinders

**3.3.2. hot rolling**

rolling after preheating

NOTE 1: The purpose of hot rolling is typically to improve the efficiency of the rolling process.

NOTE 2: Surface finish and dimensional tolerance control of hot rolled metal are generally inferior to cold rolled metal.

**3.3.3. cold rolling**

rolling without preheating

**3.3.4. double rolling**

simultaneous rolling of two foil webs in the same gap with the two webs in contact

NOTE: Sometimes the term "pack rolling" is used for this concept.

**3.3.5. temper rolling**

controlled reduction by rolling to develop the required mechanical properties

**3.3.6. levelling**

the mechanical flattening of plate, sheet or foil

NOTE: The operation is carried out by stretching, local reverse bending, and other methods.

**3.3.7. roller levelling**

flattening of plate or sheet by passing it between a series of staggered rolls

**3.3.8. stretcher levelling**

levelling carried out by uniaxial tension

**3.3.9. tension levelling**

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

**3.3.10. skin pass**

light cold rolling of sheet or strip to improve or modify the surface finish and to minimize stretcher strain on further manipulation

NOTE: This operation can increase the yield strength and to a lesser extent the tensile strength.

**3.3.11. slitting**

cutting of a coiled sheet into two or more widths by the use of rotary shears

**3.3.12. trimming**

removal of excess metal from the edges of a coiled sheet

NOTE: This term is sometimes also used for other semi-finished product.

**3.3.13. blanking (closed cut)**

production of blanks by stamping on a blanking press with closed cut

**3.3.14. shearing**

cutting of metal by the use of a press or guillotine

**3.3.15. milling (of plate)**

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

NOTE: Removal of metal by etching is often termed "chemical milling".

**3.3.16. core (of coil)**

hollow cylinder on which a coiled product may be wound that forms the inside diameter of a coil

**3.3.17. liner**

the slab of coating metal that is placed on the core alloy and is subsequently rolled down to clad sheet as composite

**3.3.18. deburring ‡**

a method whereby the raw slit edge of metal is removed by rolling or filing

**3.4. Extrusion, drawing and finishing of extruded/drawn products**

**3.4.1. extrusion (process)**

process in which a billet in a container is forced under pressure through an aperture of a die

**3.4.2. direct extrusion**

extrusion process with relative movement between billet and container

**3.4.3. indirect extrusion**

extrusion process without relative movement between billet and container

**3.4.4. extrusion press**

machine consisting essentially of a container, a ram or other pressure-applying device, and a die, used for extrusion

**3.4.5. container**

hollow cylinder in an extrusion press from which the billet is extruded

**3.4.6. tool**

term typically referring to the dies, mandrels, etc., used in the production of extruded or drawn profiles or tube

**3.4.7. extrusion die**

block of steel having one or more holes of the required contour through which a billet is forced

**3.4.8. porthole die**

extrusion die that incorporates a mandrel as an integral part of the die assembly

NOTE 1: Bridge, spider and self-stripping dies are special forms of porthole die.

NOTE 2: Hollow profiles or tubes extruded by a porthole die are characterized by one or more longitudinal extrusion seams.

**3.4.9. extrusion ratio**

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

**3.4.10. press discard (extrusion); extrusion butt**

that portion of an extrusion billet that is left unextruded

**3.4.11. extrusion effect**

increased tensile properties in the longitudinal direction of an extruded product caused by a characteristic non-recrystallized structure in certain alloys

**3.4.12. extrusion seam**

region in an extruded product where metal has been welded together in the extrusion die because of high pressure and elevated temperature

NOTE: The extrusion seam is not visible on the extruded product unless an appropriate surface treatment, e.g. etching and anodising, has been made.

**3.4.13. longitudinal extrusion seam**

extrusion seam in a hollow profile or a tube, parallel to the extrusion direction, which has been formed after creating two or more streams of metal and rejoining them around the mandrel of a porthole or bridge die

NOTE 1: Extrusion seams are naturally occurring in porthole/bridge dies.

NOTE 2: This concept is sometimes termed "charge weld".

**3.4.14. transverse extrusion seam**

extrusion seam which is formed when two subsequent billets are welded together in the extrusion die

**3.4.15. contour**

that portion of the outline of a transverse cross-section of an extruded shape that is represented by a curved line or curved lines

**3.4.16. straightening**

correcting operation of a drawn or extruded product, to fulfil the requirements concerning tolerances on form and dimensions

**3.4.17. roller straightening**

straightening of an extruded or drawn product by passing it through a series of adequately arranged rolls

NOTE: For round products, this process is typically called "reeling".

**3.4.18. reeling (of wire)**

winding of a wire onto a reel, bobbin or drum

**3.4.19. shaving**

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

## **3.5. Other forming operations**

**3.5.1. close-to-form forging; near net-shape forging**

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

**3.5.2. coining (of forged material)**

final cold forging operation applied to obtain close tolerances

**3.5.3. controlled compression**

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

**3.5.4. closed die**

forging dies, typically in pairs, into which impressions have been cut to impart the required shape

**3.5.5. deep drawing**

forming a deeply recessed part by forcing sheet metal to undergo plastic flow between dies, typically without substantial thinning of the sheet

**3.5.6. drawing and ironing**

deep drawing followed by substantial thinning of the sheet in the gap between a cylinder and a ring

**3.5.7. impact extrusion**

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

**3.5.8. superplastic forming**

forming of alloy sheet, typically biaxial, which has been specially processed to have fine grain size and a low flow stress at a critical strain rate and temperature, resulting in very large plastic deformation

NOTE: Forming is typically carried out using low gas pressure to force the sheet against a single surface tool.

**3.5.9. hydroforming**

forming of a hollow profile or a tube in a die by use of a liquid under high pressure

**3.6. Thermal treatment**

**3.6.1. thermal treatment**

heating, holding at elevated temperature and cooling of the solid metal in such a way as to obtain desired metallurgical structure or properties

NOTE 1: Heating for the sole purpose of hot working (see 3.6.2 preheating) is excluded from the meaning of this term.

NOTE 2: The term "heat treatment" is used for the same concept as a synonym.

**3.6.2. preheating**

process in which the material is raised to an elevated temperature for the start of the first operation of forming solid metal

NOTE: In some cases preheating can be combined with homogenization.

**3.6.3. homogenizing**

process whereby metal is heated to temperatures near the solidus temperature and held at that temperature for varying lengths of time in order to reduce microsegregation and modify the form and composition of intermetallic phases, which typically results in an improved formability by hot and/or cold working

**3.6.4. controlled atmosphere**

atmosphere in which the partial pressures of the gases and the temperature are maintained within specified limits so as to minimize (or more rarely induce) certain reactions between the atmosphere and the product treated, e.g. oxidation

**3.6.5. temper**

condition of the metal produced by mechanical and/or thermal processing, typically characterized by a certain structure and specified properties

**3.6.6. annealing**

thermal treatment to soften metal by reduction or removal of strain hardening resulting from cold working and/or by coalescing precipitates from the solid solution

**3.6.7. flash annealing**

annealing carried out by heating quickly and, if necessary, holding for a short time at an appropriate temperature, typically in continuous furnaces

**3.6.8. partial annealing**

annealing of a cold worked metal to reduce the strength to a controlled, but not fully softened, level

**3.6.9. recrystallization annealing**

annealing to obtain complete recrystallization of the metal

**3.6.10. super annealing**

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

**3.6.11. stabilizing; stabilization**

thermal treatment, typically at low temperatures, used to accelerate constitutional or structural changes in a solid metal in order to promote stability in dimensions, in mechanical properties, in structure or in internal stress under service conditions

**3.6.12. thermal stress relieving**

reduction of internal stresses by thermal treatment

**3.6.13. overheating**

heating a product, beyond the intended temperature, which may result in the melting of certain constituents and a reduction in mechanical properties

NOTE: Typically, overheated metal cannot be reclaimed by thermal or mechanical treatment.

**3.7. Solution heat treatment, quenching and ageing**

**3.7.1. solution heat treatment**

heating an alloy to a suitable temperature for sufficient time to allow one or more soluble constituents to enter into solid solution, where they are retained in a supersaturated state after quenching

**3.7.2. furnace solution heat treatment**

heating an alloy to a suitable temperature in a furnace and holding for a sufficient time to allow one or more soluble constituents to enter into solid solution, where they are retained in a supersaturated state after quenching

**3.7.3. extrusion press solution heat treatment**

heating an alloy to a suitable temperature then extruding, while holding for sufficient time to allow one or more soluble constituents to enter into solid solution, where they are retained in a supersaturated state after quenching

**3.7.4. forging press solution heat treatment**

heating an alloy to a suitable temperature and then forging, while holding for sufficient time to allow one or more soluble constituents to enter into solid solution, where they are retained in a supersaturated state after quenching

**3.7.5. rolling mill solution heat treatment**

heating an alloy to a suitable temperature, rolling the material to final thickness, while holding for sufficient time to allow one or more soluble constituents to enter into solid solution where they are retained in a supersaturated state after quenching

**3.7.6. quenching**

cooling a metal from an elevated temperature by contact with a solid, a liquid or a gas, at a rate rapid enough to retain most or all of the soluble constituents in solid solution

**3.7.7. air quenching**

quenching of a product by forced air, e.g. ventilators

**3.7.8. hot line quenching**

quenching of a rolled product on its exit from hot mill

**3.7.9. press quenching**

quenching of an extruded product on its exit from the extrusion press

**3.7.10. as-quenched condition**

condition of an alloy during the time immediately following quenching and before the mechanical properties have been significantly altered by precipitation hardening

**3.7.11. quenching stress**

non-uniform stress retained within the metal after quenching

**3.7.12. critical quenching rate**

minimum mean cooling rate from solution treatment temperature necessary to enable an alloy to possess certain mechanical properties in the precipitation hardened condition

**3.7.13. incubation period (quenching)**

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

**3.7.14. transfer period (quenching)**

the time between removing the metal from the solution treatment furnace and contact with the quenching medium

**3.7.15. ageing**

treatment of a metal aiming at a change in its properties by precipitation of intermetallic phases from supersaturated solid solution

NOTE 1: Ageing can be a treatment at room temperature (natural ageing) or a thermal treatment (artificial ageing).

NOTE 2: In North America the term "aging" is used.

**3.7.16. precipitation hardening**

increase in strength and hardness caused by precipitation of intermetallic phases from supersaturated solid solution

**3.7.17. age softening**

decrease in strength and hardness at room temperature in certain strain hardened alloys containing magnesium

**3.7.18. delayed ageing**

process where an alloy is kept below room temperature in order to prevent or delay precipitation from supersaturated solid solution

NOTE: After returning to room temperature precipitation process will continue normally.

**3.7.19. peak ageing**

artificial ageing under temperature and time conditions that result in maximum tensile strength

**3.7.20. under-ageing**

artificial ageing below peak ageing temperature and time conditions resulting in slightly reduced tensile strength and improved ductility, compared with peak aged metal

**3.7.21. over-ageing**

artificial ageing beyond peak ageing temperature and time conditions, in order to improve selected metallurgical characteristics of the metal, e.g. resistance to stress corrosion or intergranular corrosion

NOTE: Over-ageing results in reduced tensile properties compared with peak aged metal.

**3.7.22. step ageing**

artificial ageing typically carried out in two successive stages at different specified temperatures

**3.7.23. ramp ageing**

step ageing involving a time-controlled increase or decrease in temperature between the specified temperatures, either in steps or continuously

**3.7.24. pre-ageing**

short thermal treatment applied after quenching, but before significant precipitation hardening occurs

## **3.8. Electrochemical and chemical treatment**

**3.8.1. electrochemical brightening**

electrochemical treatment to improve the reflectivity of a surface

**3.8.2. electropolishing**

polishing of a metal surface by making it anodic in an appropriate electrolyte

**3.8.3. anodised metal**

metal with an anodic layer, produced by an electrolytic oxidation process in which a metal surface layer is converted to an oxide layer having protective, decorative or functional properties

**3.8.4. clear anodised metal**

metal with a substantially colourless, translucent anodic oxidation finish

**3.8.5. colour anodised metal**

anodised metal coloured either during anodising or by subsequent colouring processes

**3.8.6. integral colour anodised metal**

metal that has been anodised using an appropriate (typically organic acid based) electrolyte which produces a coloured finish during the anodising process itself

**3.8.7. electrolytically colour anodised metal**

metal with an anodic oxidation layer that has been coloured by the electrolytic deposition of a metal or metal oxide into the pore structure

**3.8.8. dyed anodised metal**

metal with an anodic oxidation layer coloured by absorption of dye-stuff or pigments into the pore structure

**3.8.9. combination colour anodised metal**

metal with an anodic oxidation layer that is coloured by electrolytic colouring or produced by integral colour anodising followed by absorption dyeing

**3.8.10. interference colour anodised metal**

metal with an anodic oxidation layer coloured by means of optical interference effects, as intended

**3.8.11. bright anodised metal**

anodised metal with a high specular reflectance as the primary characteristic

**3.8.12. protective anodising**

anodising where protection against corrosion or wear is the primary characteristic and appearance is secondary or of no importance

**3.8.13. decorative anodising**

anodising where a decorative finish with a uniform or aesthetically pleasing appearance is the primary characteristic

**3.8.14. architectural anodising**

anodising to produce an architectural finish to be used in permanent, exterior and static situations where both appearance and long life are important

**3.8.15. hard anodised metal**

anodised metal on which the anodic oxidation finish has been produced with wear and/or abrasion resistance as the primary characteristic

**3.8.16. sealing**

treatment of anodised metal by hydrothermal processes carried out after anodising to close the pores of the anodic layer and to reduce the absorption capacity of the coating

**3.8.17. cold impregnation; cold sealing**

sealing at temperatures significantly below 100°C, but higher than room temperature

**3.8.18. significant surface**

the part of the product covered or to be covered by the anodised layer and for which this layer is essential for serviceability and/or appearance

**3.8.19. chemical brightening**

chemical treatment to improve the reflectivity of a surface

**3.8.20. chemical polishing**

polishing of a metal surface by immersion in a solution of chemical reagents

**3.8.21. degreasing**

removal of substances from the surface of a product which may negatively affect the subsequent surface treatment, e.g. oil or grease, typically by a suitable organic solvent or an aqueous detergent

**3.8.22. etching**

selective dissolution of the surface of a metal in a liquid, typically caustic soda, with the intention to improve the surface aspect or to prepare the surface for further treatment or for inspection

NOTE 1: Etching can also be performed by an electrochemical process.

NOTE 2: Caustic etching is important to produce the required product appearance in architectural and decorative anodising.

NOTE 3: The term "pickling" for this concept is not a preferred term within the aluminium industry.

**3.9. Coating**

**3.9.1. coating (organic)**

process in which a coating material is applied on a metallic substrate, including cleaning and chemical pretreatment

NOTE 1: This term covers a one-side or two-side, single or multiple application of liquid or powder coating materials which are subsequently cured.

NOTE 2: This term also covers laminating with plastic films.

**3.9.2. coil coating**

continuous coating of a coiled metal sheet

**3.9.3. backing coat**

single coating of any type with no particular requirements for appearance, malleability, corrosion protection, etc., typically on the reverse side of the coated product

**3.9.4. conversion coating**

inorganic pretreatment applied to a metal surface by dipping or spraying or the use of a roll-coater to build up a stable oxide film to enhance coating adhesion and to retard corrosion

NOTE 1: Liquids containing chromates or phosphates are often used for conversion coating.

NOTE 2: For many applications, chromate pretreatments have been replaced by non-chromate pretreatments.

**3.9.5. priming**

application of a coating material, often combined with a corrosion inhibitor, after suitable pretreatment, over which a subsequent coating layer will be applied

**3.9.6. pretreatment priming**

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

**3.9.7. single coat system**

single coating either with requirements on appearance, malleability, corrosion protection, subsequent painting, etc., or as a primer with special properties regarding adhesion and corrosion protection for post-painting applications

**3.9.8. multiple coat system**

system comprising a primer or a base coat, possibly intermediate coat(s), and a top coat with particular requirements on appearance, malleability, corrosion protection, etc.

**3.9.9. organic coating**

paint or lacquer film on a coated product produced from wet paint or from powder coating, or the laminated organic film

**3.9.10. film coating**

organic film applied to a substrate to which an adhesive and, as appropriate, a primer has been applied beforehand

**3.9.11. lacquering**

coating with a formulation based on a dissolved material which forms a transparent layer primarily after drying by evaporation of the solvent

**3.10. Mechanical surface treatment and surface finish**

**3.10.1. mechanical polishing**

polishing with a flexible rotating mop carrying an abrasive compound

**3.10.2. grinding**

removal of material by means of abrasives contained in, or bonded to, a rigid or flexible holder

**3.10.3. finishing**

grinding with a coarse abrasive to remove superficial defects, either to produce a decorative finish or preparatory to further processing

**3.10.4. buffing**

mechanical finishing operation in which fine abrasives are applied to a metal surface by rotating fabric wheels for the purpose of developing a lustrous finish

**3.10.5. shot blasting**

projection of abrasive grit, e.g. sand, small particles of steel, glass, plastic beads or other materials, or a mixture of abrasive grit, water and air on a product in order to obtain a roughened surface topography

NOTE 1: Depending upon the particle size used for this process, a matte or satin finish is produced.

NOTE 2: Surface contamination from the blast media can require additional cleaning.

NOTE 3: The term "blast cleaning" is also used for this concept.

**3.10.6. brushing**

mechanical roughening of a surface, typically with rotating brushes

**3.10.7. tumbling; barrelling**

treatment of products in a rotating container in the presence of abrasives and water for deburring or to produce a variety of surface textures

**3.10.8. finish**

the characteristics of the surface of a product

**3.10.9. matte finish**

diffuse finish typically produced by rolling, etching, brushing or blast cleaning

**3.10.10. mirror finish**

finish after rolling or polishing with high specular reflectivity

**3.10.11. satin finish**

fine-textured matte finish, mainly by special roll grinding

**3.10.12. scratch-brushed finish**

matte or satin finish produced by abrasion with rotating wire brushes

**3.10.13. embossed finish**

pattern mechanically impressed on a surface by rolling or pressure

**3.10.14. mill finish**

finish, naturally occurring after rolling

**3.10.15. natural oxide film**

oxide film that forms naturally on the metal and is relatively impervious to atmospheric attack

**3.10.16. visible surface**

surface of the semi-finished product which is intended to be visible in final use

**3.11. Marking, packaging and delivery**

**3.11.1. packaging**

operation comprising the choice and preparation of an adequate package for specified products and the action of packing

**3.11.2. packing**

operation by which the product is enveloped in wrapping and/or enclosed in containers or otherwise secured

**3.11.3. marking**

application of numbers, letters, labels, tags, symbols or colours, for identification and handling instruction during shipping, handling and storage

**3.11.4. all-over marking**

method of identifying products 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

**3.11.5. cast number**

number by which the cast is identified

NOTE: The cast number typically includes the number of the melt from which the cast has been made,

**3.11.6. pallet**

load board designed to be moved by materials handling equipment e.g. fork-lift trucks

**3.11.7. manufacturer**

company in which a specifically identified production process, related to a product, is performed

**3.11.8. supplier**

person, company, or other organization being the contractual partner of the purchaser of a specified product

NOTE: A supplier can be a manufacturer or a distributor.

**3.11.9. purchaser**

person, company, or other organization that purchases a specified product

NOTE: The purchaser is the contractual partner of the supplier

**3.11.10. order document**

document or set of documents to which supplier and purchaser agreed at the time of ordering

NOTE: An ordering document can be an order of the purchaser confirmed by the supplier or a quotation of the supplier confirmed by the purchaser

### **3.12. Aluminium scrap and recycling operations**

#### **3.12.1. (aluminium) scrap**

raw material, destined for trade and industry, mainly consisting of aluminium resulting from the collection and/or recovery of

- metal that arises as by-product at various production stages; or
- products after use

to be used for the production of wrought and cast alloys and for other production processes

#### **3.12.2. new scrap**

scrap arising from the various production stages of aluminium products, before the aluminium product is sold to the final user

#### **3.12.3. internal scrap**

new scrap that is melted in the same company where this scrap has been generated

NOTE: Internal scrap is not traded on the market and typically does not appear in trade statistics

NOTE: Internal scrap which is transferred between sites of the same company still is termed "internal scrap"

NOTE: Also known as turn-around scrap, in-house scrap, run-around scrap or home scrap

#### **3.12.4. old scrap**

scrap arising from products after use

#### **3.12.5. traded scrap**

scrap that is traded on the market

NOTE: Traded scrap typically meets requirements on characteristics agreed upon between supplier and purchaser.

#### **3.12.6. skimmings**

material composed of intimately mixed aluminium, aluminium oxides and gas, which has been removed from the surface of the molten metal or from the bottom and walls of liquid metal containers, e.g. furnaces or transport ladles or transfer channels

NOTE: This concept is also termed "dross".

#### **3.12.7. black dross**

skimmings from scrap remelting, characterised by a dark colour, typically resulting from oxides of alloying elements or attached soot particles

NOTE: This term should not be used for salt slag, see 3.13.1.

#### **3.12.8. metallics**

fraction of skimmings with high concentration of metallic aluminium, produced by crushing or grinding of skimmings by means of ball mills, hammer mills, impactors, etc., followed by screening

#### **3.12.9. spills**

scrap with high recoverable aluminium content consisting of metal which spilled over the rim or penetrated through leakages of liquid metal containers, e.g. furnaces, crucibles, troughs or dies

#### **3.12.10. cuttings**

scrap mainly of sheet arising from cutting, blanking, shearing or similar operations

#### **3.12.11. turnings**

new scrap consisting of grains, chips, curls, flakes etc. resulting from machining or other operations

#### **3.12.12. used beverage cans (UBC)**

scrap consisting of used aluminium beverage cans

#### **3.12.13. used aluminium packaging**

scrap consisting of used packaging which contain aluminium in recoverable portions

#### **3.12.14. incinerator scrap**

aluminium scrap that has been separated from the combustion residues of an incinerator

#### **3.12.15. processed scrap**

scrap that has undergone one or more processing operation(s)

#### **3.12.16. loose scrap**

scrap that has not undergone any operation of compacting and from which pieces can be individually picked up

#### **3.12.17. shredded scrap**

scrap that has been reduced into smaller parts by a shredder operation

**3.12.18. granulated scrap**

scrap consisting of pieces in a size range between a few millimetres and a few centimetres, generated by processing larger pieces through machines such as crushers, knife mills, hammer mills or choppers

**3.12.19. compacted scrap**

scrap in the form of compacted briquettes or bales

NOTE: Typically, briquettes are much smaller and have a higher density than bales.

**3.12.20. clean scrap**

scrap that does not contain foreign material

**3.12.21. coated scrap**

scrap consisting of pieces with any kind of coating, e.g. paint, varnish, printing ink, plastics, paper, metal

NOTE: Anodised scrap is not included.

**3.12.22. anodised scrap**

scrap consisting of pieces of anodised aluminium, including colour anodised aluminium

**3.12.23. wrought scrap**

scrap consisting of pieces of wrought aluminium

**3.12.24. scrap for direct melting**

scrap considered by the purchaser suitable for direct charging into his melting furnaces

**3.12.25. foreign material**

any material other than aluminium or aluminium alloys being physically identifiable as part of scrap consignment

NOTE 1: Foreign material can be attached to pieces of scrap or separate.

NOTE 2: Examples of foreign material are powder, water, oil or other fluids, grease, wood, plastic, glass, stones, paper, sand, non-aluminium metals, dry paints, inks, lacquers, rubber, dirt.

NOTE 3: The term "foreign substance" is also used.

**3.12.26. free iron**

any ferrous metal, either magnetic or non-magnetic, being a foreign material

**3.12.27. steriles / inerts**

inorganic components of scrap which are separate from the pieces of scrap and do not significantly modify the chemical composition of the metal after melting, e.g. stones, soil, glass, dust

**3.12.28. contaminant**

physical or chemical component of the scrap which, if not properly monitored and managed, negatively affects the quality of the scrap as a raw material for certain applications or shows hazardous properties during certain operations

**3.12.29. volatile substance**

foreign material that is removed from the scrap by appropriate thermal processes, e.g. drying or decoating, before the scrap melts

NOTE 1: Examples of volatile substances are water, rolling oils, emulsions, paints, plastics or paper.

NOTE 2: Volatile substances can be removed in separate operations or directly in specially designed melting furnaces.

**3.12.30. moisture**

liquid that adheres to the scrap and can be identified in the delivered lot

NOTE: Moisture can be due to fabrication, usage, pick up during storage or transport.

**3.12.31. baling/briquetting**

production of bales/briquettes from loose scrap

**3.12.32. delacquering/decoating**

removal of any solid organic surface layer, e.g. lacquer, paint, wax or adhering solid organic material, e.g. plastic or rubber, by thermal or mechanical treatment

NOTE: Delacquering of used beverage cans or similar packaging scrap can include the removal of entrapped moisture.

**3.12.33. shredding**

reduction of the size of pieces of scrap, end-of-life products or compacted scrap into small pieces, by operations such as crushing or tearing

**3.12.34. shearing**

reduction of the size of pieces of bulky scrap by cutting operations

**3.12.35. sorting**

separation of different fractions of loose scrap, manually or by other methods

**3.12.36. sink and float**

processes where materials with different densities are separated through air flotation or heavy media systems

**3.12.37. drying**

thermal treatment of scrap which intends to remove liquid foreign materials, typically water, oil or emulsions

**3.12.38. scrap consignment**

ordered quantity of scrap of the same requirements, sent in one or more scrap shipments

**3.12.39. scrap shipment**

scrap quantity sent with one separate shipping document, e.g. a truck load

**3.12.40. classification**

set of procedures adopted by the purchaser which intends to verify the compliance the received scrap with the contractual purchasing terms

**3.12.41. declared mass**

mass of a scrap consignment as declared on a shipment document

**3.12.42. gross mass**

mass of a scrap consignment which includes all foreign materials, but does not include packaging material and dunnage

**3.12.43. net mass**

mass of aluminium scrap in a scrap consignment after deduction of foreign materials

NOTE: Foreign material can be deduced by calculation, based on product information and test results.

**3.12.44. metal content**

aluminium portion of a scrap inspection lot which is obtained after deduction of foreign material

**3.12.45. metal yield**

portion of a scrap consignment that, after proper melting, can become useable metal

NOTE 1: The metal yield is typically expressed as percentage (mass fraction).

NOTE 2: This term is often defined in a different way in contracts.

**3.12.46. net metal yield**

portion of the net mass of scrap that, after proper melting, can become useable metal

NOTE: The net metal yield is typically expressed as percentage (mass fraction).

### **3.13. Residues of the aluminium industry**

**3.13.1. salt cake; salt slag**

residue after remelting of aluminium scrap in a rotary furnace, consisting of fluxing salt in which metallic and non-metallic particles are entrapped in amounts that exhaust its fluxing properties

NOTE: Fluxing salt is used for refining in rotating furnaces in order to

1. cover the molten metal to prevent oxidation,
2. increase the net metal yield,
3. clean the metal from non-metallic inclusions and dissolved metallic impurities (e.g. calcium and magnesium), and
4. enhance thermal efficiency in the furnace.

**3.13.2. salt slag residue**

insoluble residue of the salt slag recycling process, i.e. after removal of the coarse metallic particles, namely aluminium, and of the water soluble components

NOTE: Salt slag residue consists of metal oxides, mainly aluminium oxide, with a small portion of silicates and very fine metallic aluminium particles.

**3.13.3. sludge from flue gas treatment**

sludgy residue occurring after the treatment of emissions with water and a possible subsequent filtration in order to remove undesired components

**3.13.4. furnace linings**

refractory residues consisting of linings that have been removed from furnaces, crucibles and launders after use

NOTE: According to the way of furnace operation furnace linings can be contaminated by contact with salt, alloying elements or impurities of the melt.

**3.13.5. spent liquid metal filter material**

refractory residues consisting of spent rigid media filter or bed filter material used in cast-houses in order to clean and distribute aluminium melts

NOTE: This residue often contains significant amounts of aluminium.

**3.13.6. spent graphite parts (from melt treatment devices)**

residues consisting of components of graphite and other carbon materials which typically have been used at high temperatures in contact with liquid aluminium, e.g. as tubes for flushing gas treatment

**3.13.7. spent blasting grit**

abrasive grit which has been used for blast cleaning of castings, typically mixed with fine particles removed from the surface of the casting which has been treated

**3.13.8. filter dust from cast-houses**

dust residue obtained from the dust filtration, typically from the melting operation in aluminium cast-houses, which can contain calcium compounds, salt flux compounds, aluminium oxide, and graphite

**3.13.9. fines**

fine-grained portion obtained from the milling of skimmings holding a low metal content, but a high content of aluminium oxides and other oxides

**3.13.10. waste water treatment residues**

oily sludge, which is obtained from an internal waste water purification of a plant

**3.13.11. oil filter residues (from rolling mills)**

residues, typically consisting of fine-grained, claylike filter media, e.g. diatomite, obtained from the filtration of cold rolling oils, which contain rolling oil and a small amount of rolling fines

**3.13.12. spent hot rolling emulsion**

hot rolling emulsion which can no longer be used or recovered for its purpose

**3.13.13. spent roll grinding emulsion**

water-base emulsion from roll grinding, from which the grinding residue has been removed by filtration, but which is no longer capable of fulfilling its original function and must be discarded

**3.13.14. roll grinding sludge**

sludge from roll grinding, typically consisting of aluminium particles, iron particles and emulsion residue, from which the roll grinding emulsion has been removed by filtration

**3.13.15. mixed spent oils**

mixture of different oil residues from metal working machines, typically together with major portions of water and other impurities

NOTE: Mixed spent oils of a high viscosity are often called oil sludge.

**3.13.16. spent machine oil**

oil residues, mainly from lubrication and hydraulic oil, typically resulting from the maintenance of machines, mixed with small portions of water and other impurities

**3.13.17. lacquer sludge**

fluid lacquers originally intended to be used for lacquering of aluminium that are no longer usable for their purpose, e.g. lacquers which can be pumped from containers

**3.13.18. waste coating materials**

dried or hardened lacquers which are no longer fluid and no longer usable for their purpose, e.g. residues in paint containers

**3.13.19. sludge from anodising/etching**

sludgy residues resulting from the partial removal of the liquid phase from spent bath after anodising or etching

**3.13.20. sludge from surface treatment, free from chromium**

sludge obtained from neutralisation and dewatering of spent chromium-free liquids used for chemical or electrochemical surface treatment of aluminium

**3.13.21. sludge from surface treatment, contaminated with chromium**

sludge obtained from neutralisation and dewatering of spent liquids which contain chromium and are used for chemical or electrochemical surface treatment of aluminium

**3.13.22. spent caustic etching liquid**

etching liquid which is no more capable of fulfilling its original function and therefore is discarded

**3.13.23. aluminium brushing dust**

dust, typically consisting of pyrophorous metallic aluminium and aluminium oxides generated by mechanical brushing of aluminium surfaces

**3.13.24. spent hardening salts**

bath or hardening salts for the hardening of machine parts, mainly extrusion dies, which are no longer usable, both containing cyanides, or a mixture of both components

**3.13.25. spent mixed solvents**

organic solvents which are no longer capable of fulfilling their original function and must be discarded, typically mixed or contaminated with impurities

## **4. Sampling, testing and product characteristics**

### **4.1. Sampling and preparation of test-pieces**

**4.1.1. consignment**

quantity of product of the same specification, sent in a single shipment

NOTE: The term "consignment" has in North America a different connotation, meaning shipped to an intermediate point and not invoiced until consumed.

**4.1.2. inspection lot**

consignment or part thereof submitted for inspection or sampling, characterised by a set of identical criteria, e.g. grade or alloy, temper, size, shape, thickness or cross-section or fabrication batch

**4.1.3. melt**

quantity of molten metal that has simultaneously undergone the same preparatory treatment in the furnace before the casting operation

**4.1.4. cast**

quantity of products cast simultaneously from the same melt

NOTE 1: The different ingots of a cast can have different dimensions.

NOTE 2: This term is not used for castings.

NOTE 3: In North America, multiple "drops" are made with one cast number.

**4.1.5. heat treatment lot**

quantity of products of the same grade or alloy, form, thickness or cross-section and produced in the same way, heat treated in one furnace load, or such products solution treated and subsequently precipitation treated in one furnace load

NOTE 1: More than one solution-treatment batch can be included in one ageing furnace load.

NOTE 2: For heat treatment in a continuous furnace (vertical or horizontal), the products continuously heat-treated during a specified time (e.g. 8 h) can be considered as one heat treatment lot.

**4.1.6. sample**

representative part, portion or piece of an inspection lot selected for inspection or testing

**4.1.7. specimen**

that portion of a sample taken for evaluation of some specific characteristics or properties or for the purpose of producing test pieces

NOTE: In North America the terms "coupon" is often used instead.

**4.1.8. test piece**

piece taken from a sample or a specimen which is suitably prepared for test

NOTE: In North America the terms "coupon" and "specimen" are often used instead.

**4.1.9. limiting sample**

sample or specimen showing to which extent quality characteristics of a product are acceptable

NOTE: Limiting samples typically demonstrate "just acceptable" and "just unacceptable" forms of a quality characteristic.

**4.1.10. layout sample**

prototype of a product, typically a casting or a forging, that has been subjected to detailed measurement to demonstrate conformance to an engineering drawing which sets forth the required characteristics

NOTE: A layout sample can be the "first article" of a production or a sample taken out of the running production.

**4.1.11. longitudinal direction †**

the direction of the major metal flow in a working operation; also referred to as rolling direction or extrusion direction depending upon working method

**4.1.12. transverse direction**

any direction perpendicular to the longitudinal direction

**4.1.13. long transverse direction**

transverse direction parallel to the major sectional dimension of the product

**4.1.14. short transverse direction**

transverse direction parallel to the minor sectional dimension of the product

NOTE 1: For hand forgings, this direction is typically the direction of forging.

NOTE 2: For rolled or extruded products the (wall) thickness is measured in the short transverse direction.

**4.1.15. cross direction ‡**

the direction at right angles to the direction of rolling, extruding or drawing

**4.2. Tests**

**4.2.1. test**

operation to which the test piece is subjected in order to measure or classify a property

**4.2.2. inspection**

activities necessary to compare characteristics of a product with specified requirements

**4.2.3. macro-etching test**

test for which the metal is etched in order to reveal its macrostructure

**4.2.4. dye penetrant test; liquid penetrant inspection**

non-destructive test characterised by the following steps:

- immersing the clean and degreased test piece in a dye penetrant or covering it with a layer of dye penetrant;
- removing the residual superfluous dye penetrant from the surface of the test piece after a specified period;
- visual control of the surface of the test piece, possibly after a developer has been applied, if the dye seeps out from any flaws and cracks

NOTE: The dye can be a fluorescent dye which can be detected by means of an U.V. lamp.

**4.2.5. ultrasonic test**

non-destructive test employing high-frequency sound waves for the location and assessment of size of internal defects

**4.2.6. eddy current test**

non-destructive test in which eddy-current flow is induced in the test piece, mainly for the assessment of different properties, e.g. the soundness of tubes, presence of specific surface or sub-surface defects, microstructure or thickness of surface layers

**4.2.7. tensile test**

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

**4.2.8. pressure test**

hydraulic or pneumatic test applied to a tube or a hollow profile to ensure that the metal will withstand a specified pressure for a specified time without unacceptable leakage or distortion

**4.2.9. fracture test**

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

**4.2.10. torsion test**

test in which a test piece is twisted axially for a given number of revolutions

**4.2.11. bend test**

test intending to assess bending characteristics and ductility of a product by bending a test piece under defined conditions, typically with a predetermined radius and angle

NOTE: The predetermined radius is called bend radius.

**4.2.12. hardness test**

test for the determination of hardness properties and the estimation of strength properties, typically by relating the load applied to an indenter of prescribed form to the depth or surface area of the impression produced

**4.2.13. bore test (of tube)**

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

**4.2.14. drift expanding test (of tube)**

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

NOTE: In North America, the term "flare test" is used for this concept.

**4.2.15. cut-up test (of forgings)**

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

**4.2.16. flattening test (of tube)**

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

**4.2.17. flanging test**

test in which a disc-shaped rim of predetermined size is formed at the end of a tube or hollow profile test piece to assess its suitability for specific application, e.g. the manufacture of tubular rivets or flanged products

NOTE: The flanging test typically assesses the soundness of extrusion seams.

**4.2.18. wrapping test**

test consisting of winding the wire a specified number of turns around a mandrel of diameter stated in the material specification

NOTE: The test can also include a specified programme of unwinding or of unwinding and rewinding.

**4.2.19. earing test**

test consisting of deep-drawing of a blank into a cup in order to assess the earing properties of the metal

**4.2.20. Erichsen test**

cupping test in which a piece of sheet metal, restrained only at the periphery, is deformed by a cone-shaped spherically ended plunger until fracture occurs; the height of the cup in millimetres at fracture initiation is a measure of the ductility

**4.2.21. Mullen test**

measurement of bursting strength of foil by applying increasing pressure to a defined area of the test piece until it ruptures

**4.3. Mechanical properties**

**4.3.1. mechanical properties**

properties of a material that are associated with elastic and inelastic reaction when force is applied, or that involve the relationship between stress and strain; for example, modulus of elasticity, tensile strength, endurance limit

NOTE 1: These properties are often incorrectly referred to as physical properties.

NOTE 2: The mechanical properties obtained by a tensile test, e.g. modulus of elasticity in tension, tensile strength and elongation are often termed "tensile properties".

**4.3.2. modulus of elasticity; Young's modulus**

ratio of stress applied to a material to corresponding strain throughout the range where they are proportional

NOTE: As there are three kinds of stresses, so there are three kinds of moduli of elasticity for any material — modulus of elasticity in tension, modulus of elasticity in compression, and modulus of elasticity in shear (shear modulus).

#### **4.3.3. tensile strength**

ratio of maximum load before rupture in a tensile test to original cross-sectional area

NOTE: Also called "ultimate tensile strength".

#### **4.3.4. proof strength; yield strength**

stress necessary to produce a defined small plastic deformation in a material under uniaxial tensile or compressive load

NOTE 1: If the plastic deformation under tensile load is defined as 0,2%, then the term "proof strength  $R_{p0,2}$ " or "yield strength 0,2%" is used.

NOTE 2: The term "proof strength" is used in European and ISO standards, whereas the term "yield strength" is used in North American documents.

#### **4.3.5. elongation (to fracture)**

the percentage increase in distance between two marks on a test piece, termed "gauge marks", that results from straining the test piece in tension to fracture between these gauge marks

NOTE 1: The elongation depends on the distance between the gauge marks.

NOTE 2: The elongation depends on the cross-sectional dimensions of the test piece. For example, the values obtained from sheet specimens will be lower for thin sheet than for thicker sheet. The same is true for extrusions.

NOTE 3: Elongation is the simplest and most common representation of the ductility of the material.

#### **4.3.6. gauge length**

distance between two gauge marks on a test piece between which the test piece ruptures during a tensile test

NOTE 1: The gauge length before applying the load is termed "original gauge length".

NOTE 2: Sometimes the spelling "gage" is used.

#### **4.3.7. elongation A**

percentage elongation after fracture related to a gauge length of  $5,65 \cdot \sqrt{S_0}$ , where  $S_0$  is the initial cross-sectional area of the test-piece

NOTE 1: The earlier designation  $A_5$  should be avoided.

NOTE 2: For round cross-sections the gauge length is calculated as  $5 \cdot d$ , where  $d$  is the diameter of the test-piece between the gauge marks.

NOTE 3: In some US documents the gauge length is also specified as  $4 \cdot d$ .

#### **4.3.8 elongation $A_{50mm}$**

percentage elongation after fracture related to an original gauge length of 50 mm and a constant original width of the test piece between the gauge marks

NOTE 1: Existing standards specify the original width of the test piece between the gauge marks as 12,5 mm.

NOTE 2: In the US, the gauge length is often 2 inches, i.e. 50,8 mm.

#### **4.3.9 shear strength**

maximum gross stress, i.e. maximum force divided by original cross section, which a material withstands before fracture when submitted to a shear test

NOTE 1: Shear strength is an important quality characteristic of rivets.

NOTE 2: The shear strength is normally about 60% of the tensile strength.

#### **4.3.10. creep rupture strength**

maximum gross stress which the material withstands when submitted to sustained loading at a defined temperature, typically above 100°C

#### **4.3.11. Poisson's ratio**

ratio between longitudinal elongation and transverse contraction in uniaxial testing

NOTE: The Poisson's ratio is typically at 0,33 for all alloys and tempers.

#### **4.3.12. hardness**

resistance of a metal to plastic deformation, typically measured by indentation

#### **4.3.13. Brinell Hardness, HB**

resistance to penetration of a spherical indentor under standardized conditions

NOTE 1: HB is approximately equal to  $0,3 \cdot R_m$  when  $R_m$  is the tensile strength, expressed in MPa.

NOTE 2: If tungsten carbide as indentor material is specified, e.g. ISO 6506-1, then the designation HBW is used.

**4.3.14. Vickers Hardness, HV**

resistance to penetration of a square-based pyramidal diamond indenter under standardized conditions

NOTE: HV is approximately equal to  $1,10 \cdot HB$ .

**4.3.15. ductility**

ability of a material to deform plastically before fracturing

**4.3.16. workability; malleability; formability**

relative ease with which a metal can be formed by rolling, extruding, drawing, deep drawing, forging, etc.

**4.3.17. deep drawability**

suitability of a flat product for forming of deeply recessed parts by means of deep drawing, often assessed by the maximum drawing ratio, i.e. the ratio of the maximum drawable blank diameter to a given stamp diameter

**4.3.18. toughness**

ability of a metal to absorb energy and deform plastically before fracturing, typically measured by the energy absorbed in a notch impact test or the area under the stress-strain curve in tensile testing

**4.3.19. fracture toughness**

parameter indicating the resistance of a material to crack extension

**4.3.20. impact resistance; shock resistance**

ability to resist impact

**4.3.21. internal stress**

stress set up within a metal as a result of previous operations, e.g. casting, thermal treatment or working

**4.3.22. residual stress**

internal stress left in the finished product after all fabricating operations, including stress relieving where applicable, have been carried out

**4.3.23. fatigue**

tendency for a metal to break under conditions of repeated cyclic stressing considerably below the tensile strength

NOTE: Fatigue fractures begin as minute cracks that grow under the action of the fluctuating stress.

**4.3.24. fatigue strength**

maximum stress amplitude that can be sustained by a product for a specified number of cycles generally expressed as the stress amplitude giving a 50% probability of fracture after a given number of load cycles

**4.3.25. endurance limit**

limiting stress below which a material will withstand a specified large number of cycles of stress

**4.3.26. earing**

wavy projections spaced symmetrically around the rim of a deep drawn product due to non-uniform directional properties in the aluminum and/or by improperly adjusted tooling

**4.3.27. pressure tightness**

absence of leakage at a specified pressure

**4.3.28. spring back effect**

elastic partial recovery of a metal after cold forming operations such as bending

**4.3.29. brittleness ‡**

tendency of a metal or material to fracture without undergoing appreciable plastic deformation

**4.4.30. minimum bend radii ‡**

minimum recommended radii expressed in terms of thickness for bending sheets and plates without fracturing in a standard press brake with air bend dies; values are normally given in standards where required

**4.4. Product characteristics on form and dimensions**

**4.4.1. straightness**

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

**4.4.2. lateral curvature; lateral bow †**

deviation of a longitudinal edge from a straight line

Note: Also called "camber".

**4.4.3. flatness**

the extent to which the surface of a product approaches a plane

**4.4.4. longitudinal bow; longitudinal arch; longitudinal curvature**

deviation from straightness in the plane of a flat product along the main axis, as measured by use of a baseplate on which the product is positioned so that its own weight minimizes the curvature

**4.4.5. transverse bow; transverse arch**

curvature in the plane of a flat product perpendicular to the main axis

**4.4.6. concavity**

inward curvature across the width of a flat product

**4.4.7. convexity**

outward curvature across the width of a flat product

**4.4.8. crown**

difference in thickness between one of the edges and the centre of a rolled product

**4.4.9. twist**

The extent to which a product is twisted around its longitudinal axis

**4.4.10. concentricity**

the extent to which the inner and outer walls of round tube have a common centre of curvature

**4.4.11. eccentricity**

deviation between the centres of curvature of the inner and outer walls of round tube

NOTE 1: Eccentricity is typically determined as the difference between the mean wall thickness and minimum or maximum wall thickness at any one cross-section.

NOTE 2: The permissible degree of eccentricity can be expressed by a plus and minus wall-thickness tolerance.

**4.4.12. ovality**

departure of the cross-section of a round tube, rod or bar or wire from a true circle

**4.4.13. squareness**

characteristic of having adjacent sides, planes or axes meeting at 90°

**4.4.14. corner**

convex junction between two surfaces

**4.4.15. fillet**

concave junction between two surfaces

**4.4.16. angularity**

conformity to or deviation from, specified angular dimensions in the cross section of a shape or bar

**4.4.17. forging plane**

reference plane or planes normal to the direction of applied force from which all draft angles are measured

**4.4.18. baseplate**

thick, stable plate having a horizontal surface of a very high, controlled flatness, mainly used for controlling the straightness, flatness, twist etc. of rolled and extruded products

**4.4.19. circumscribing circle**

circle that will just contain the cross-section of a profile, typically designated by its diameter

**4.4.20. mean diameter (of round rod/bar or tube)**

average of any two diameters measured at right angles in the same cross-sectional area

**4.4.21. mean wall thickness (of tube)**

average of the largest and the smallest wall thickness of tube measured in the same plane perpendicular to the axis of the tube

**4.4.22. tolerance**

maximum allowable deviation from a specified characteristic

**4.4.23. tolerance range**

difference between the maximum limit of a parameter and the minimum limit of a parameter of a specified characteristic

NOTE: The tolerance range is an absolute value without sign.

**4.4.24. gauge (thickness is the preferred term) ‡**

commonly used to describe the thickness of aluminium sheet or coil in inches / millimeters.

NOTE: This is not to be confused with comparative gauges such as Brown & Sharpe, US Standard, and Manufacturers sheet steel, which use a number to designate a non-corresponding thickness, i.e. "20

Gauge" is .037 in. on the Brown & Sharpe scale

#### **4.5. Physical and metallurgical product characteristics**

##### **4.5.1. physical properties**

the properties, other than mechanical properties, that pertain to the physics of a material; for example, density, electrical conductivity, heat conductivity, thermal expansion

##### **4.5.2. electrical resistivity**

electrical resistance of a given material related to unit length and unit cross- section area

##### **4.5.3. electrical conductivity**

the reciprocal of electrical resistivity

##### **4.5.4. coefficient of thermal expansion**

expansion per unit length when the material temperature is raised one degree

NOTE: The coefficient of thermal expansion varies slightly with the temperature and is typically measured at 20°C.

##### **4.5.5. liquidus temperature**

temperature at which total melting of the solid is achieved upon heating from the solid state, or at which solid first appears upon cooling from the liquid state

##### **4.5.6. solidus temperature**

temperature at which liquid first appears upon heating from the solid state

NOTE 1: For some alloys prior homogenizing may significantly raise the solidus temperature (AA7075 for example).

NOTE 2: Exceeding the solidus temperature during heat-treating has extremely deleterious effect on material properties.

##### **4.5.7. density**

mass per unit volume

##### **4.5.8. specific heat capacity**

amount of heat necessary to raise the temperature of 1 kg of material by 1K, under constant pressure

##### **4.5.9. wettability**

degree to which a metal surface can be wet by water

NOTE: Wettability allows the assessment of the amount of residual lubricants on the surface.

##### **4.5.10. microstructure**

structure of a metal as revealed by microscopic examination of a surface, typically after mechanical and/or chemical preparation, e.g. polishing and micro-etching

##### **4.5.11. macrostructure**

structure of a metal as revealed by visual examination of a surface without any enhanced magnification, typically after mechanical and/or chemical preparation, e.g. machining and macro-etching

##### **4.5.12. cast structure; as-cast structure**

structure of an ingot or casting characterized by shape and orientation of grains, segregation of alloying elements and impurities and distribution of intermetallic phases

##### **4.5.13. metal grain**

crystal of uniform grid orientation within a metal

##### **4.5.14. equiaxed grains**

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

##### **4.5.15. grain size**

mean size of metal grains expressed in terms of the number of grains per unit area or unit volume, as the mean grain diameter or an appropriate index

##### **4.5.16. cell size (of a cast metal)**

mean size of subdivisions of metal grains in ingots or castings, caused by microsegregation and/or by precipitation of intermetallic phases during solidification

##### **4.5.17. dendrite**

crystal that has a treelike branching pattern, being most evident in cast metals slowly cooled through the solidification range

#### **4.5.18. dendrite arm spacing**

mean distance of adjacent secondary arms of a dendrite

NOTE: The dendrite spacing can only be determined if a dendritic cast structure with primary and secondary dendrite arms can be clearly detected.

#### **4.5.19. grain flow**

change of the shape of metal grains under the influence of hot or cold working

#### **4.5.20. grain growth**

growth of larger metal grains at the expense of smaller ones

#### **4.5.21. recrystallization**

nucleation and growth of new undeformed metal grains in a deformed metal

NOTE: Deformed metal grains are characterised by a tight network of dislocations

#### **4.5.22. critical strain (recrystallization)**

the minimum amount of cold work or cold deformation necessary to initiate recrystallization during subsequent annealing or solution heat treatment

NOTE: One can distinguish between the lower critical strain corresponding to the onset of the recrystallization, which typically causes coarse grain, and the somewhat higher upper critical strain that produces a fine recrystallized grain.

#### **4.5.23. fluidity**

ability of a liquid metal to flow (into a mould)

#### **4.5.24. anodising quality ‡**

an indication that special attention has been paid to the metallurgical characteristics and surface quality of the aluminium sheet or extrusion to assure that a uniform and blemish-free decorative anodic film will form during anodising

NOTE 1: Normally a special order between customer and supplier.

NOTE 2: See ISO 7599 Annex A for guide to grades of aluminium for anodizing.

#### **4.5.25. fibrous structure ‡**

the characteristic of wrought metal that indicates directional properties - it is revealed by etching a longitudinal section or manifested by the fibrous appearance of a fracture

### **5. Visual quality characteristics**

#### **5.1. General terms**

##### **5.1.1. quality characteristic**

inherent characteristic of a product, process or system related to a requirement

NOTE 1: Inherent means existing in something, especially as a permanent characteristic.

NOTE 2: A characteristic assigned to a product, process or system (e.g. the price of a product, the owner of a product) is not a quality characteristic of that product, process or system.

NOTE 3: For aluminium products a quality characteristic can be a dimension, a mechanical property, a physical property, a functional characteristic, or the appearance.

##### **5.1.2. visual quality characteristic**

quality characteristic which can be detected by visual inspection of the material, sometimes after preparation of a sample and/or by use of a microscope

NOTE 1: The existence of a visual quality characteristic does not necessarily imply a nonconformity, nor does it have necessarily any implication as to the usability of a product.

NOTE 2: A visual quality characteristic can be rated on a scale of severity, in accordance with appropriate specifications, e.g. to establish whether or not the product is of acceptable quality.

#### **5.2. Typical terms for ingots and castings**

##### **5.2.1. cold shut (cast product)**

linear discontinuity in a cast surface caused by freezing of the melt meniscus in contact with the mould and the liquid metal flowing over the solidified metal

##### **5.2.2. segregation**

non-uniform distribution or concentration of impurities or alloying elements that arises during the solidification of an ingot

**5.2.3. macrosegregation**

segregation over macroscopic distances

**5.2.4. microsegregation**

segregation over microscopic distances, typically associated with cellular or dendritic solidification

**5.2.5. gravity segregation**

macrosegregation caused by the settling out of heavy constituents, or rising of light constituents in a solidifying melt

**5.2.6. inverse segregation**

macrosegregation caused by interdendritic liquid metal in a solidifying ingot or casting which is sucked towards its surface, due to volume shrinkage caused by solidification

**5.2.7. surface segregation (unwrought product)**

thin surface layer of a cast metal characterized by concentrations of the alloying elements significantly different from the concentration in the melt; the layer is generated by interdendritic liquid metal which has been pushed through the surface of the cast metal during solidification by gravity

NOTE: Surface segregation layers of non-uniform thickness which give a cast surface a characteristic appearance are also called "liquations".

**5.2.8. hot crack**

crack formed in a cast metal or in a welding because of internal stress developed on cooling at the solidus temperature or slightly above

NOTE: For castings the term "hot tear" is also used.

**5.2.9. cold crack**

crack in cast metal initiated by mechanical stresses at temperatures significantly below the solidus temperature

**5.2.10. shrinkage cavity**

void left in cast metals as a result of solidification shrinkage

**5.2.11. porosity**

fine holes or pores within a cast metal

**5.2.12. gas porosity**

porosity caused by entrapped gas or by evolution of dissolved hydrogen during solidification

**5.2.13. twin columnar grains (TCG)**

macrostructure of rapidly solidified cast metal characterized by a twin plane in the centre of each dendrite stem parallel to the direction of crystal growth

NOTE: Twin columnar grains are often termed "feather crystals".

**5.2.14. butt curl**

deformation of the bottom butt of a rolling ingot caused by a sudden increase of heat transfer by water impingement at the start of the DC casting process

**5.2.15. butt swell**

convexity of the rolling faces of a rolling ingot in the area of the bottom butt caused by non-stationary cooling conditions during the start of semi-continuous casting

**5.2.16. misrun**

open hole in the wall of a casting where the part did not fill completely before solidification.

**5.3. Visual quality characteristics related to form and dimension**

**5.3.1. off gauge**

deviation of a dimension of a product, e.g. width or wall thickness, from the specified tolerances

**5.3.2. kink**

abrupt deviation from straightness

NOTE 1: The term "hook" is sometimes used for this concept.

NOTE 2: For rolled products, this term is also used for an abrupt bend or deviation from flatness, which is caused by localized bending during handling.

**5.3.3. buckle**

departure from flatness represented by alternate bulges and hollows or waves along the length of a product

**5.3.4. centre buckle**

departure from flatness represented by alternate bulges and hollows along the length and in the centre across the width of a product, the edges of which remain comparatively straight

NOTE: Centre buckles are also termed "centre waves" or "pockets".

**5.3.5. quarter buckle**

departure from flatness represented by alternate bulges and hollows along the length and is approximately at both quarter points across the width of a product, the edges of which remain comparatively straight

**5.3.6. edge buckle †**

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

NOTE: Edge buckles are also termed "edge waves" or "wavy edges" or "edge ripples".

**5.3.7. dent**

sharply delimited surface impression on the metal, often caused by a blow from another object

**5.3.8. expansion dent**

localized surface deviation from flat generated by expansion of vapor during thermal treatment of cold rolled coiled sheet

**5.3.9. repeating dent**

dent appearing periodically, often caused by a particle adhering to a rotating roll over which the metal has passed

**5.3.10. corner turn-up**

deviation of the corner(s) of a sheet from a perfectly flat plane on which it rests, often caused by distortion, buckle or twist condition

**5.3.11. belled edge †**

excessive build-up of material on edge(s) of a coil during a rewinding operation; typical causes include excessive edge burr, turned edge, and "dog bone" shaped cross sectional profiles

**5.3.12. coil orientation †**

with the coil core vertical ("eye-to-sky") and viewed from above, a trace of the metal edge from the ID to the OD involves clockwise movement

**5.3.13. clockwise coil †**

with the coil core vertical ("eye-to-sky") and viewed from above, a trace of the metal edge from the ID to the OD involves clockwise movement

**5.3.14. counter-clockwise (anti-clockwise) coil †**

with the coil core vertical ("eye to the sky") and viewed from above, a trace of the metal edge from the ID to the OD involves a counter-clockwise (anti-clockwise) movement

**5.3.15. coil set; coil curvature †**

a lengthwise curve or set found in coiled strip metals following its coil pattern; a departure from longitudinal flatness; can be removed by roller or stretcher levelling from metals in the softer temper ranges

**5.3.16. coil set, reversed †**

longitudinal bow in an unwound coil in the direction opposite to the curvature of the wound coil

**5.3.17. telescoping; coned-out coil †**

transverse slipping, primarily in one direction of successive wraps or layers of a coil so that the edge of the coil is conical rather than flat - this can occur during the coiling operation or during subsequent handling

**5.3.18. eye-to-sky ‡**

coil packed on a skid so the coils are laying flat and ID is vertical (common packing orientation)

**5.3.19. eye-to-wall; eye-to-side ‡**

coil packed on a skid so that the coils are standing on edge and the ID is horizontal (less common packing orientation)

**5.3.20. dish ‡**

a concave surface departing from a straight line edge to edge - indicates transverse or across the width

**5.3.21. canning ‡**

dished distortion in a flat or nearly flat surface, sometimes referred to as oil canning

**5.3.22. oscillation ‡**

uneven wrap in coiling and lateral travel during winding; improper alignment of rolls over which the metal passes before rewinding and insufficient rewind tension are typical causes

**5.3.23. loose coil end ‡**

a condition in a coil due to insufficient tension which creates a small void between adjacent wraps

NOTE: This condition is also called "loose wrap"

**5.4. Visible surface quality characteristics on wrought products, mainly mechanical**

**5.4.1. mark**

damage in the surface of the product, e.g. indentation or raised surface

NOTE: If the source of the mark is known, a more precise composite term is used, e.g. "chatter marks".

**5.4.2. chatter marks**

regularly spaced superficial marks, transverse to the rolling or extrusion direction, produced by vibration between the metal and the working surface during fabrication

**5.4.3. ripple marks**

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

**5.4.4. rub mark**

mark consisting of a large number of very fine scratches or abrasions

NOTE 1: A rub mark can occur by metal-to-metal contact, movement in handling and movement in transit.

NOTE 2: Rub marks are often termed "friction scratches". More severe forms of rub marks, caused by handling are often termed "handling scratches" or "handling marks".

**5.4.5. stop mark**

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

**5.4.6. stretcher grip mark**

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

**5.4.7. arbor mark**

surface damage in the vicinity of a coil ID caused by contact with a roughened, damaged or non-circular arbor

**5.4.8. bite mark**

periodical imperfection on the surface of a rolled product, generally perpendicular to the rolling direction, because of a mark on a roll coating caused by the initial feeding of the ingot

**5.4.9. roll mark**

periodic raised or depressed area on a rolled product formed during rolling by the imprint of a damage on the roll

NOTE 1: The repeat distance is a function of the offending roll diameter.

NOTE 2: A greatly enlarged roll mark whose height or depth is very shallow is often called a "roll bruise mark".

**5.4.10. knife mark**

continuous scratch (which may also be creased) near a slit edge of a rolled product, caused by sheet contacting the slitter knife

**5.4.11. whip mark**

surface abrasion on a rolled product, generally diagonal to the rolling direction, caused by a fluttering action of the metal as it enters the rolling mill

**5.4.12. stretcher jaw mark**

cross-hatched appearance left by jaws at the end(s) of metal that has been stretched, if insufficient metal has been removed after the stretching operation

**5.4.13. herringbone marks**

superficial markings taking the form of alternate light and dark bands forming a V or W pattern across the width of rolled metal

**5.4.14. pinch marks**

pressed-in folds in rolled products, generally running parallel to the direction of rolling

**5.4.15. indentation**

small hollow mark on the surface of a the metal

NOTE: An indentation is also termed "pit".

**5.4.16. scratch †**

sharp linear indentation in the surface of the metal

NOTE 1: This is sometimes referred to as a "nick".

NOTE 2: A gross / deep scratch is often called a "gouge".

**5.4.17. rolled-in scratch**

scratch that occurs during the fabricating process and is subsequently rolled over

NOTE: A rolled in scratch often appear as a greyish white ladder showing distinct transverse lines within the longitudinal indentation.

**5.4.18. drawn-in scratch**

scratch occurring during the fabricating process and subsequently drawn over, making it relatively smooth to the touch

**5.4.19. machine scratch**

straight indentation in the rolling direction of a rolled product, caused by contact with a sharp projection on the equipment

**5.4.20. tension scratches**

short longitudinal indentations parallel to the rolling direction of rolled products, resulting from relative movement between adjacent wraps of the coil during unwinding or rewinding

NOTE: Tension scratches are sometimes termed "block marks".

**5.4.21. burnish streak**

bright region on the sheet caused by excessive roll surface wear

**5.4.22. coating streak**

banded surface appearance on a rolled product caused by non-uniform adherence of roll coating to a work roll during hot and/or cold rolling

NOTE: If generated in the hot rolling process, it is also called "hot mill pickup".

**5.4.23. grinding streak**

streak with a helical pattern appearance transferred to a rolled product from a work roll

**5.4.24. herringbone streak**

elongated alternately bright and dull chevron markings

**5.4.25. pickup**

irregular surface appearance caused by intermittent adhesion between the forming tools and the metal

NOTE: The condition of excessive friction between the forming tool and the metal is often termed "galling".

**5.4.26. sliver**

thin elongated piece of the parent metal on the surface of a product, completely or partially detached

NOTE: Slivers are often rolled-over surface damages.

**5.4.27. broken surface**

surface having multiple minute cracks running transverse to the direction of working

**5.4.28. lamination**

internal crack or separation aligned parallel to the principal surfaces of a rolled product

**5.4.29. broken edge**

edge of a rolled product containing cracks, splits, or tears, caused by inability to be formed without fracturing

**5.4.30. alligatoring; crocodiling**

longitudinal doubling and/or splitting at both ends of a slab in a plane parallel to the rolled surface occurring during the first passes of the reversing hot mill

**5.4.31. roll grind**

the uniform ground finish on the work rolls which is imparted to the sheet or plate during rolling

**5.4.32. burr**

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

**5.4.33. crazing ‡**

a macroscopic effect of numerous surface tears, transverse to the rolling direction, which can occur when the entry angle into the cold mill work rolls is large; can also occur when forming or heat-treating an anodized product (see also cross-hatched surface)

**5.4.34. cross-hatched surface ‡**

a surface having innumerable minute cracks running normal to the direction of working

**5.4.35. hair, slitter ‡**

minute hair-like sliver along edge(s) due to shearing or slitting operation

**5.4.36. mill edge ‡**

the edge of strip, sheet or plate in the as rolled state i.e. unsheared

**5.5. Visible quality characteristics of wrought products, mainly metallurgical**

**5.5.1. structural quality characteristics**

quality characteristics caused by an inadequate microstructure or macrostructure

**5.5.2. flow lines**

the line pattern which shows the direction of flow on the surface

**5.5.3. streak**

superficial band or line which produces a non-uniform surface appearance

NOTE 1: Wide streaks are often termed "stripes".

NOTE 2: According to the source or appearance of the streak, a more precise composite term is used, e.g. "dirt streak".

**5.5.4. bearing streak**

longitudinal discolouration, typically lighter than the surrounding metal, which can occur as a result of uneven cooling, where there are large changes in wall thickness

**5.5.5. structural streak**

streak on etched or anodised surfaces resulting from a non-homogeneous distribution of intermetallic phases in the metal, resulting from the solidification conditions of the ingot

**5.5.6. fir-tree structure**

macrostructure of an etched and/or anodised metal, characterized by areas of different gloss, with sharp boundaries between these areas, caused by different types of intermetallic phases

NOTE: Fir-tree structure originates in the macrostructure of the ingot. It can be found in sections of the ingot, after appropriate mechanical pretreatment and subsequent etching or anodising.

**5.5.7. inclusion**

extraneous material accidentally entrapped into the liquid metal during melting or melt treatment or entrapped in the metal surface during hot or cold working

**5.5.8. razor streak**

thin streak on the surface of a wrought product, only visible after chemical or electrochemical surface treatment, caused by an inclusion or a cluster of inclusions in the metal which has been elongated during hot and/or cold working

NOTE: Razor streaks are often termed "stringer inclusions".

**5.5.9. inclusion mark**

mark in a metal surface resulting from an inclusion

NOTE: The term includes marks with still visible inclusions or voids from which the inclusions have left.

**5.5.10. blister**

raised spot, inside hollow, on the surface of products caused by the penetration of a gas into a subsurface zone typically during thermal treatment

NOTE: A void resulting from blister that has ruptured is often termed "blow hole".

**5.5.11. core blister**

blister resulting from a gas-filled hole in the core of the metal

NOTE: In thin-walled products, core blisters are visible on both opposite surfaces.

**5.5.12. orange peel**

surface pattern on formed products which occurs when a coarse grain structure is present in the formed surface of the metal

**5.5.13. coarse grain ‡**

excessively large grains typically produced by a heat treatment

**5.6. Discolorations, oil/dirt, stains and corrosion**

**5.6.1. water stain**

superficial surface oxidation due to the reaction of water films held between closely adjacent metal surfaces such as between wraps of a coil or sheets in a stack

NOTE 1: The appearance of a water stain varies from iridescent in mild cases to white, gray, or black in more severe instances.

NOTE 2: Sometimes the term "water stain corrosion" is used for this concept.

**5.6.2. oil stain**

surface discoloration which may vary from dark brown to white, produced during thermal treatment by incomplete decomposition of residual lubricants on the surface

**5.6.3. heat treat stain**

discoloration due to non-uniform oxidation of the metal surface during heat treatment

**5.6.4. surface bloom**

surface discoloration that can develop on metal during exposure to moist atmospheres or during thermal treatment

**5.6.5. heat treat contact mark**

brownish, iridescent, irregularly shaped stain with a slight abrasion located somewhere within the boundary of the stain, resulting from metal-to-metal contact during the quenching of solution heat-treated flat sheet or plate

**5.6.6. smudge; smut**

dark film of debris, sometimes covering large areas, deposited on the sheet during rolling or left on the surface of a metal after electroplating or etching

**5.6.7. rolled-in metal**

particle of metal, other than the parent metal, rolled into the surface of the product

NOTE: Rolled-in particles of the parent metal are called slivers, see 5.4.26.

**5.6.8. rolled-in dirt**

imperfection or defect in the surface of a rolled product caused by particles as dust or dirt entrapped between the rolling cylinder and the rolled product

**5.6.9. dirt streak**

surface discoloration which may vary from gray to black, is parallel to the direction of rolling, and contains rolled in foreign debris

NOTE: Dirt streaks typically result from extraneous material that drops from an overhead location onto the rolling surface and are shallow enough to be removed by etching or buffing.

**5.6.10. grease streak**

narrow discontinuous streak caused by excessive lubricant dripping on the surface of the rolled product during rolling

**5.6.11. high lube**

nonconformity, when lubricant limit exceeds the maximum agreed upon limit measured in weight per unit area

**5.6.12. low lube**

nonconformity, when the lubricant does not meet the minimum agreed upon limit measured in weight per unit area

**5.6.13. buff streak**

dull continuous streak caused by smudge build-up on a buff used at shearing or other operations

**5.6.14. corrosion**

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

**5.6.15. exfoliation corrosion**

corrosion that progresses approximately parallel to the metal surface, causing layers of the metal to be elevated by the formation of corrosion product

**5.6.16. stress corrosion cracking**

cracking resulting from selective directional attack caused by the simultaneous interaction of sustained tensile stress at an exposed surface with the chemical or electro-chemical effects of the surface environment

**5.6.17. intercrystalline corrosion; intergranular corrosion**

corrosion occurring preferentially at the grain boundaries of a metal

**5.6.18. pitting corrosion**

localized corrosion resulting in small pits or craters in a metal surface

**5.6.19. filiform corrosion**

corrosion in the form of irregularly distributed thread-like filaments that can occur under certain conditions under coatings

**5.6.20. oxidation ‡**

chemical combination with oxygen to form an oxide; exposure to atmosphere sometimes results in localized, excessive oxidation of the exposed surface, hence a staining or discoloration; this effect is increased with temperature increase (see water stain)

**5.6.21. fretting corrosion ‡**

action that results in surface damage, especially in a corrosive environment, when there is relative motion between solid surfaces in contact under pressure

NOTE: This is commonly called "traffic marking".

**5.7. Visible quality characteristics of coated and clad products**

**5.7.1. flaking**

condition in coated sheet where portions of the coating become loosened due to inadequate adhesion

**5.7.2. flow lines**

lines on the surface of painted sheet, brought about by incomplete levelling of the paint

NOTE: This term is sometimes used for the line pattern revealed by etching, which shows the direction of plastic flow on the surface or within a wrought structure.

**5.7.3. pick-off**

the transfer of portions of the coating from one surface of the sheet to an adjacent surface due to poor adhesion of the coating

**5.7.4. holiday**

uncoated area of a coated product due to non-wetting of the metal surface by the coating

**5.7.5. solvent pop**

blister and/or void in the coating resulting from trapped solvents released during curing process

**5.7.6. oven scratch**

scratch which is caused by moving contact of coating against a non-moving object in an oven

**5.7.7. striation**

longitudinal non-uniform coating thickness caused by uneven application of the liquid coating

**5.7.8. coating build-up**

coating thickness greater than nominal in localized area of sheet, typically along edges, due to uneven application techniques

**5.7.9. lube spot**

non-uniform, extraneous deposit of lube on the coated sheet

**5.7.10. bond blister**

raised spot on only one surface of the metal whose origin is a blister between the cladding and core in a clad product

**5.7.11. coating blister**

blister in the coating of an alclad or a clad product

**5.7.12. diffusion staining**

patchy discoloration, which may vary from gray to brown, that can arise from diffusion in clad metal

NOTE: When diffusion staining has the form of a streak, then the term "diffusion streak" is used.

**5.7.13. pressure mottling**

non-uniform surface appearance of a laminated product resulting from uneven pressure distribution between adjacent layers of the product

**5.8. Typical terms for extruded products and forgings**

**5.8.1. pickups**

torn, comma-like spots on the surface of extruded products caused by a local material deposition on the surface of the die

**5.8.2. die line**

continuous longitudinal line formed on an extruded or drawn product caused by minor irregularities and/or the build-up of aluminium or non-metallic inclusions, on the bearing surfaces of the die

**5.8.3. broken die**

deviation from the desired cross-section due to the absence of a certain portion of the die used to extrude the profile

**5.8.4. carbon mark**

gray or black surface marking caused by contact with carbon run-out blocks

**5.8.5. snap mark**

band-like pattern around the full perimeter of an extruded section and perpendicular to its length, caused by an abrupt change of an extrusion parameter during the process

NOTE: If the extrusion process is abruptly suspended, then the term "stop mark" is used.

**5.8.6. saw lubricant stain**

yellow to brown area of surface discolouration at the ends of the extruded length, caused by certain types of saw lubricants if they are not removed from the metal prior to the thermal treatment

**5.8.7. torn surface**

deep longitudinal rub mark resulting from abrasion by extrusion or drawing tools

**5.8.8. multi-hole die effect**

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

**5.8.9. reeling marks**

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

**5.8.10. stretcher strain markings**

permanent surface distortion in the form of either flamboyant patterns or Lueders lines that can appear under certain conditions on stretched extruded products

NOTE: The onset of these markings varies according to the type of metal and the degree of stretching.

**5.8.11. hot spot**

dark, grey or black surface patch on anodised extruded products caused by non-uniform cooling after extrusion

NOTE: Hot spots are typically associated with lower hardness and coarse magnesium silicide precipitates.

**5.8.12. traffic marks**

abrasions, typically dark in colour, resulting from relative movement between metal surfaces during handling and transit, e.g. during the cooling of profiles on the run-out table

NOTE: A mirror image of a traffic mark is observed on the adjacent contacting surface.

**5.8.13. speed cracks, speed tear**

transverse surface cracks, preferentially in corner radii or extremities of a profile, caused by localized high temperature

**5.8.14. peripheral coarse grain**

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

**5.8.15. non-fill**

deviation of a die forging from the specified form caused by failure of metal to fill a forging die impression

**5.8.16. mismatch**

deviation of a die forging from the specified form caused by opposing die halves not being in perfect alignment

**5.8.17. flash**

thin protrusion at the parting line of a die forging which forms when metal, in excess of that required to fill the impressions, is forced between the die interfaces

**5.8.18. cold shut (forging); lap**

discontinuity in a forging caused by metal flowing into a section from two directions

**5.8.19. fin**

thin projection on a forging resulting from trimming or from the metal under pressure being forced into hairline cracks in the die or around die inserts

**5.8.20. back-end defect ‡**

Cone-shaped defect resulting from surface contaminations and oxides being built up in front of the advancing extrusion pad due to container friction resulting in annular separation in the rear of the extrusion

**5.8.21. front-end defect ‡**

parabolically shaped defect caused by oxides and lubricants from the billet end surface being trapped when two billets are welded during billet to billet extrusion resulting in poor welds; (also known as transverse-weld defect)

## **5.9. Typical terms for foil and formed products**

**5.9.1. roll holes (foil)**

holes in foil with a maximum diameter > 0,2 mm which occur at regular intervals throughout the rolled coil length

**5.9.2. perforations (foil)**

holes in foil with a maximum diameter > 0,2 mm which occur randomly throughout the rolled coil length

**5.9.3. pinholes (foil)**

voids in foil of gauge below 20 µm of normally round or oval shape with a maximum diameter < 0,2 mm, randomly distributed

**5.9.4. broken matte finish**

non-uniform surface on the matte side of packed rolled foil, caused by bright spots

**5.9.5. sticking (of foil)**

adherence of contacting foil surfaces in a coil sufficient to interfere with the normal ease of unwinding

**5.9.6. strain mark**

Surface patterns on formed products of some alloys after straining

NOTE 1: Stochastical flamboyant strain marks which can appear at low strain levels are often termed "strain marks type A".

NOTE 2: Strain marks which appear between 45° and 55° to the straining direction are often termed "strain marks type B" or "Lueders lines".

**5.9.7. looper lines**

closely spaced symmetrical lines on the surface of a formed product, typically occurring after a deep drawing operation

## 6. Glossary

age softening - 3.7.17	bond blister - 5.7.10	coated scrap - 3.12.21
ageing - 3.7.15	bore test (of tube) - 4.2.13	coating (organic) - 3.9.1
aging - 3.7.15	brazing rod - 2.9.10	coating blister - 5.7.11
air quenching - 3.7.7	brazing sheet - 2.6.8	coating build-up - 5.7.8
alclad one side sheet/plate 2.6.26	brazing wire - 2.9.22	coating streak - 5.4.22
alclad plate - 2.6.26	bridge die - 3.4.8	coefficient of thermal expansion - 4.5.4
alclad sheet 2.6.26	bridge tube - 2.8.16	coil coating - 3.9.2
alclad tube - 2.8.20	bright anodised metal - 3.8.11	coil curvature - 5.3.15
alclad wire - 2.9.24	bright two-side foil - 2.7.13	coil orientation - 5.3.12
alligatoring - 5.4.30	Brinell hardness, HB - 4.3.13	coil set - 5.3.15
all-over marking - 3.11.4	brittleness - 4.3.29	coil set, reversed - 5.3.16
alloy - 2.2.1	broken die - 5.8.3	coiled sheet - 2.6.2
alloying element - 2.2.3	broken edge - 5.4.29	coining (of forged material) - 3.5.2
aluminium - 2.1.1	broken matte finish - 5.9.4	cold crack - 5.2.9
aluminium alloy - 2.2.2	broken surface - 5.4.27	cold heading bar - 2.9.26
aluminium brushing dust - 3.13.23	brushing - 3.10.6	cold heading rod - 2.9.26
aluminium composite material (ACM) - 2.3.5	buckle - 5.3.3	cold impregnation; cold sealing - 3.8.17
aluminium powder - 2.3.11	buff streak - 5.6.13	cold rolled plate - 2.6.5
aluminium powder product - 2.3.13	buffing - 3.10.4	cold rolled sheet - 2.6.5
aluminium scrap - 3.12.1	burnish streak - 5.4.21	cold rolling - 3.3.3
aluminum - 2.1.1	burr - 5.4.32	cold shut (cast product) - 5.2.1
angularity - 4.4.16	bus bar - 2.9.15	cold shut (forging) - 5.8.18
annealed foil - 2.7.7	bus conductor - 2.9.15	cold working - 3.2.4
annealing - 3.6.6	butt - (of a rolling ingot) - 2.4.12	cold-coined forging - 2.10.9
anodised metal - 3.8.3	butt curl - 5.2.14	cold-drawn bar - 2.9.7
anodised scrap - 3.12.22	butt swell - 5.2.15	cold-drawn rod - 2.9.6
anodising quality - 4.5.24	can stock - 2.6.9	cold-finished bar - 2.9.5
anodising sheet - 2.6.7	canning - 5.3.21	cold-finished profile - 2.8.4
anti-clockwise coil - 5.3.14	carbon mark - 5.8.4	colour anodised metal - 3.8.5
arbor mark - 5.4.7	cast - 4.1.4	combination colour anodised metal - 3.8.9
architectural anodising - 3.8.14	cast number - 3.11.5	compacted scrap - 3.12.19
artificial ageing - 3.7.15	cast structure - 4.5.12	concavity - 4.4.6
as-cast structure - 4.5.12	casting - 2.5.1	concentricity - 4.4.10
as-quenched condition - 3.7.10	casting alloy - 2.2.5	conductor wire - 2.9.21
back-end defect - 5.8.20	casting process - 3.1.1	coned-out coil - 5.3.17
backing coat - 3.9.3	cell size (of a cast metal) - 4.5.16	consignment - 4.1.1
baling/briquetting - 3.12.31	centre buckle - 5.3.4	consumer foil - 2.7.4
bar 2.9.2	centre waves - 5.3.4	container - 3.4.5
barrelling - 3.10.7	charge weld - 3.4.13	container foil - 2.7.3
baseplate - 4.4.18	chatter marks - 5.4.2	contaminant - 3.12.28
bearing streak - 5.5.4	chemical brightening - 3.8.19	continuous casting - 3.1.3
bend radius - 4.2.11	chemical milling - 3.3.15	contour - 3.4.15
bend test - 4.2.11	chemical polishing - 3.8.20	controlled atmosphere - 3.6.4
bite mark - 5.4.8	chemically cleaned foil - 2.7.8	controlled compression - 3.5.3
black dross - 3.12.7	chill casting process - 3.1.9	conversion coating - 3.9.4
blank - 2.3.8	circle - 2.6.33	converter foil - 2.7.2
blank - 2.6.32	circle stock - 2.6.10	convexity - 4.4.7
blanking (closed cut) - 3.3.13	circumscribing circle - 4.4.19	core (of coil) - 3.3.16
blast cleaning - 3.10.5	clad plate - 2.6.25	core blister - 5.5.11
blister - 5.5.10	clad sheet - 2.6.2	corner - 4.4.14
block marks - 5.4.18	classification - 3.12.40	corner turn-up - 5.3.10
blocker-type forging - 2.10.8	clean scrap - 3.12.20	corrosion - 5.6.14
blow hole 5.5.10	clear anodised metal - 3.8.4	corrugated sheet - 2.6.28
bolt stock - 2.9.26	clockwise coil - 5.3.13	counter-clockwise coil - 5.3.14
	closed die - 3.5.4	
	close-to-form forging - 3.5.1	
	coarse grain - 5.5.13	

coupon - 4.1.7	electrochemical brightening - 3.8.1	flatness - 4.4.3
creep rupture strength - 4.3.10	electrolytically colour anodised metal - 3.8.7	flattened wire - 2.9.19
crazing – 5.4.33	electropolishing - 3.8.2	flattening test (of tube) - 4.2.16
critical quenching rate - 3.7.12	elongation - 4.3.5	flow lines - 5.5.2
critical strain (recrystallization) - 4.5.22	elongation A - 4.3.7	flow lines - 5.7.2
crocodiling - 5.4.30	elongation $A_{50\text{mm}}$ - 4.3.8	fluidity - 4.5.23
cross-hatched surface - 5.4.34	embossed finish - 3.10.13	foil - 2.7.1
cross direction – 4.1.15	embossed foil - 2.7.6	foil stock - 2.6.11
crown - 4.4.8	embossed sheet - 2.6.29	foreign material - 3.12.25
cuttings - 3.12.10	embossed tube - 2.8.21	foreign substance - 3.12.25
cut-up test (of forgings) - 4.2.15	endurance limit - 4.3.25	forging - 2.10.1
deburring – 3.3.18	equiaxed grains - 4.5.14	forging ingot - 2.4.9
declared mass - 3.12.41	Erichsen test - 4.2.20	forging plane - 4.4.17
decorative anodising - 3.8.13	etched foil - 2.7.9	forging press solution heat treatment - 3.7.4
deep drawability - 4.3.17	etching - 3.8.22	forging stock - 2.10.11
deep drawing - 3.5.5	exfoliation corrosion - 5.6.15	formability - 4.3.16
degreasing - 3.8.21	expansion dent - 5.3.8	forming - 3.2.1
delacquering/decoating - 3.12.32	extrudate - 2.8.2	fracture test - 4.2.9
delayed ageing - 3.7.18	extruded bar - 2.9.4	fracture toughness - 4.3.19
dendrite - 4.5.17	extruded profile - 2.8.3	free iron - 3.12.26
dendrite arm spacing - 4.5.18	extruded rod - 2.9.3	free machining alloy - 2.2.10
density - 4.5.7	extruded tube - 2.8.13	fretting corrosion - 5.6.21
dent - 5.3.7	extruded wire - 2.9.18	front-end defect - 5.8.21
die casting - 2.5.5	extrusion (process) - 3.4.1	furnace linings - 3.13.4
die casting process - 3.1.10	extrusion billet - 2.4.7	furnace solution heat treatment - 3.7.2
die forging - 2.10.2	extrusion butt - 3.4.10	galling - 5.4.25
die line - 5.8.2	extrusion die - 3.4.7	gas porosity - 5.2.12
diffusion staining - 5.7.12	extrusion effect - 3.4.11	gauge – 4.4.24
direct chill (DC) casting - 3.1.2	extrusion ingot - 2.4.6	gauge length - 4.3.6
direct extrusion - 3.4.2	extrusion log - 2.4.8	grain flow - 4.5.19
dirt streak - 5.6.9	extrusion press - 3.4.4	grain growth - 4.5.20
disc - 2.6.34	extrusion press solution heat treatment - 3.7.3	grain refiner - 2.2.12
dish - 5.3.20	extrusion ratio - 3.4.9	grain size - 4.5.15
double rolling - 3.3.4	extrusion seam - 3.4.12	granulated scrap - 3.12.18
drawing - 3.2.6	eye-to-side - 5.3.19	granules - 2.3.10
drawing and ironing - 3.5.6	eye-to-sky - 5.3.18	gravity segregation - 5.2.5
drawing stock - 2.9.20	eye-to-wall - 5.3.19	grease streak - 5.6.10
drawn product - 2.3.4	fatigue - 4.3.23	grinding - 3.10.2
drawn profile - 2.8.5	fatigue strength - 4.3.24	grinding streak - 5.4.23
drawn tube - 2.8.14	feather crystals - 5.2.13	grit - 2.3.12
drawn wire - 2.9.17	fibrous structure - 4.5.25	gross mass - 3.12.42
drawn-in scratch - 5.4.18	filiform corrosion - 5.6.19	hair, slitter – 5.4.35
drift expanding test (of tube) - 4.2.14	fillet - 4.4.15	hammer forging - 2.10.6
drop forging - 2.10.5	film coating - 3.9.10	hand forging - 2.10.3
dross - 3.12.6	filter dust from cast-houses - 3.13.8	handling marks - 5.4.4
drying - 3.12.37	fin - 5.8.19	handling scratches - 5.4.4
ductility - 4.3.15	fin stock - 2.6.12	hard anodised metal - 3.8.15
dye penetrant test - 4.2.4	fines - 3.13.9	hard foil - 2.7.10
dyed anodised metal - 3.8.8	finish - 3.10.8	hardener - 2.2.11
earing - 4.3.26	fir-tree structure - 5.5.6	hardness - 4.3.12
earing test - 4.2.19	flake - 2.3.9	hardness test - 4.2.12
eccentricity - 4.4.11	flaking - 5.7.1	head (of a rolling ingot) - 2.4.11
eddy current test - 4.2.6	flanging test - 4.2.17	heat exchanger tube - 2.8.22
edge (of a rolling ingot) - 2.4.13	flare test – 4.2.14	heat treat contact mark - 5.6.5
edge buckle - 5.3.6	flash - 5.8.17	heat treat stain - 5.6.3
edge waves - 5.3.6	flash annealing - 3.6.7	heat treatment - 3.6.1
electrical conductivity - 4.5.3	flat sheet - 2.6.27	heat-treatable alloy - 2.2.8
electrical resistivity - 4.5.2		heat-treatment lot - 4.1.5
		herringbone marks - 5.4.13

herringbone streak - 5.4.24	lateral curvature - 4.4.2	milling (of plate) - 3.3.15
hexagonal bar - 2.9.14	layout sample - 4.1.10	minimum bend radii – 4.3.29
high lube - 5.6.11	levelling - 3.3.6	mirror finish - 3.10.10
high pressure die casting - 2.5.5	limiting sample - 4.1.9	mismatch - 5.8.16
high pressure die casting process - 3.1.10	liner - 3.3.17	misrun - 5.2.16
holiday - 5.7.4	finishing - 3.10.3	mixed spent oils - 3.13.15
hollow profile - 2.8.7	liquations - 5.2.7	modifier - 2.2.13
home scrap - 3.12.3	liquid penetrant inspection - 4.2.4	modulus of elasticity – 4.3.2
homogenizing - 3.6.3	liquidus temperature - 4.5.5	modulus of elasticity in compression - 4.3.2
hook - 5.3.2	lithographic sheet - 2.6.13	modulus of elasticity in shear - 4.3.2
hot crack - 5.2.8	long transverse direction - 4.1.13	modulus of elasticity in tension, - 4.3.2
hot line quenching - 3.7.8	longitudinal arch - 4.4.4	moisture - 3.12.30
hot mill pickup - 5.4.20	longitudinal bow - 4.4.4	Mullen test - 4.2.21
hot rolled plate - 2.6.4	longitudinal curvature - 4.4.4	multi-hole die effect - 5.8.8
hot rolled sheet - 2.6.4	longitudinal direction - 4.1.11	multiple coat system - 3.9.8
hot rolling - 3.3.2	longitudinal extrusion seam - 3.4.13	natural ageing - 3.7.15
hot spot - 5.8.11	looper lines - 5.9.7	natural oxide film - 3.10.15
hot tear - 5.2.8	loose coil end – 5.3.23	near net-shape forging - 3.5.1
hot working - 3.2.3	loose scrap - 3.12.16	net mass - 3.12.43
household foil - 2.7.4	loose wrap – 5.3.23	net metal yield - 3.12.46
hydroforming - 3.5.9	low lube - 5.6.12	new scrap - 3.12.2
impact - 2.10.10	low pressure die casting - 2.5.3	non-fill - 5.8.15
impact extrusion - 3.5.7	low pressure die casting process - 3.1.9	non-heat-treatable alloy - 2.2.9
impurity - 2.2.4	lube spot - 5.7.9	off gauge - 5.3.1
incinerator scrap - 3.12.14	Lueders lines - 5.9.6	oil filter residues (from rolling mills) - 3.13.11
inclusion - 5.5.7	machine scratch - 5.4.19	oil sludge – 3.13.15
inclusion mark - 5.5.9	machined plate - 2.6.31	oil stain - 5.6.2
incubation period (quenching) - 3.7.13	machining stock - 2.9.25	old scrap - 3.12.4
indentation - 5.4.15	macro-etching test - 4.2.3	one side bright mill finish sheet - 2.6.23
indirect extrusion - 3.4.3	macrosegregation - 5.2.3	orange peel - 5.5.12
inerts - 3.12.27	macrostructure - 4.5.11	order document - 3.11.10
ingot - 2.4.1	malleability - 4.3.16	organic coating - 3.9.9
ingot for casting - 2.4.5	manufacturer - 3.11.7	oscillation – 5.3.22
ingot for remelting - 2.4.4	mark - 5.4.1	ovality - 4.4.12
in-house scrap - 3.12.3	marking - 3.11.3	oven scratch - 5.7.6
inspection - 4.2.2	master alloy - 2.2.11	over-ageing - 3.7.24
inspection lot - 4.1.2	master coil - 2.6.17	overheating - 3.6.13
integral colour anodised metal - 3.8.6	master plate 2.6.18	pack rolled foil - 2.7.12
intercrystalline corrosion - 5.6.17	matrix - 2.3.6	pack rolling - 3.3.4
interference colour anodised metal - 3.8.10	matte finish - 3.10.9	packaging - 3.11.1
intergranular corrosion - 5.6.17	matte one side foil - 2.7.12	packing - 3.11.2
intermediate temper foil - 2.7.11	mean diameter (of round rod/bar or tube) - 4.4.20	Painted sheet - 2.6.21
internal scrap - 3.12.3	mean wall thickness (of tube) - 4.4.21	pallet - 3.11.6
internal stress - 4.3.21	mechanical polishing - 3.10.1	parent coil - 2.6.17
inverse segregation - 5.2.6	mechanical properties - 4.3.1	parent plate - 2.6.18
investment casting - 2.5.7	mechanically grained foil - 2.7.14	partial annealing - 3.6.8
investment casting process - 3.1.11	melt - 4.1.3	patterned foil - 2.7.6
kink - 5.3.2	metal content - 3.12.44	patterned sheet – 2.6.29
knife mark - 5.4.10	metal grain - 4.5.13	peak ageing - 3.7.22
lacquer sludge - 3.13.17	metal yield - 3.12.45	perforations (foil) - 5.9.2
lacquering - 3.9.11	metallics - 3.12.8	performance hardener - 2.2.14
laminated material - 2.3.5	microsegregation - 5.2.4	performance product - 2.2.14
lamination - 5.4.28	microstructure - 4.5.10	peripheral coarse grain - 5.8.14
lap - 5.8.18	mill finish - 3.10.14	permanent mould casting -2.5.3
lateral bow - 4.4.2	mill finish foil - 2.7.15	permanent mould casting process - 3.1.9
	mill finish sheet/plate - 2.6.22	
	mill finish sheet/plate - 2.6.22	

permanent set - 3.2.10	reflector sheet - 2.6.14	semi-hollow profile - 2.8.8
physical properties - 4.5.1	remelt ingot - 2.4.4	semi-permanent mould casting -
pick-off - 5.7.3	repeating dent - 5.3.9	2.5.4
pickup - 5.4.25	reroll stock - 2.6.6	shape - 2.8.1
pick-ups - 5.8.1	residual stress - 4.3.22	shate - 2.6.1
pig - 2.4.4	reverse side (of a sheet) - 2.6.20	shaving - 3.4.19
pinch marks - 5.4.14	ripple marks - 5.4.3	shear modulus 4.3.2
pinholes (foil) - 5.9.3	rivet stock - 2.9.27	shear strength - 4.3.9
pipe - 2.8.24	rod - 2.9.1	shearing - 3.12.34
pit - 5.4.15	rod casting - 3.1.4	shearing - 3.3.14
pitting corrosion - 5.6.18	roll bruise marks 5.4.9	sheet - 2.6.1
plate - 2.6.3	roll grind - 5.4.31	shock resistance - 4.3.20
pockets - 5.3.4	roll grinding sludge - 3.13.14	short transverse direction - 4.1.14
Poisson's ratio - 4.3.11	roll holes (foil) - 5.9.1	shot blasting - 3.10.5
porosity - 5.2.11	roll mark - 5.4.9	shredded scrap - 3.12.17
porthole die - 3.4.8	rolled bar - 2.9.9	shredding - 3.12.33
porthole tube - 2.8.16	rolled ring forging - 2.10.7	shrinkage cavity - 5.2.10
pre-ageing - 3.7.27	rolled rod - 2.9.8	significant surface - 3.8.18
precipitation hardening - 3.7.16	rolled-in dirt - 5.6.8	single coat system - 3.9.7
precision casting - 2.5.6	rolled-in metal - 5.6.7	sink and float - 3.12.36
precision forging - 2.10.4	rolled-in scratch - 5.4.17	sized tube - 2.8.15
precision profile - 2.8.10	roller levelling - 3.3.7	skimmings - 3.12.6
preheating - 3.6.2	roller straightening - 3.4.17	skin pass - 3.3.10
press discard (extrusion) - 3.4.10	rolling - 3.3.1	slab - 2.6.4
press quenching - 3.7.9	rolling face (of a rolling ingot) -	slitting - 3.3.11
pressure die casting - 2.5.5	2.4.14	sliver - 5.4.26
pressure die casting process -	rolling ingot - 2.4.10	sludge from anodising/etching -
3.1.10	rolling mill solution heat treatment	3.13.19
pressure mottling - 5.7.13	- 3.7.5	sludge from flue gas treatment -
pressure test - 4.2.8	roofing sheet - 2.6.15	3.13.3
pressure tightness - 4.3.27	round bar - 2.9.1	sludge from surface treatment,
pretreatment priming - 3.9.6	rub mark - 5.4.4	contaminated with chromium -
primary aluminium ingot - 2.4.2	run-around scrap - 3.12.3	3.13.21
priming - 3.9.5	salt cake - 3.13.1	sludge from surface treatment,
printed foil - 2.7.5	salt slag - 3.13.1 -	free from chromium - 3.13.20
processed scrap - 3.12.15	salt slag residue - 3.13.2	slug - 2.3.7
profile - 2.8.1	sample - 4.1.6	smudge; smut - 5.6.6
profiled sheet - 2.6.28	sand casting - 2.5.2	snap mark - 5.8.5
proof stress 0,2 % - 4.3.4	sand casting process - 3.1.8	solid profile - 2.8.6
protective anodising - 3.8.12	satin finish - 3.10.11	solidus temperature - 4.5.6
purchaser - 3.11.9	satin-finish sheet - 2.6.24	solution heat treatment - 3.7.1
quality characteristic - 5.1.1	saw lubricant stain - 5.8.6	solvent pop - 5.7.5
quarter buckle - 5.3.5	scalping - 3.1.7	sorting - 3.12.35
quenching - 3.7.6	scrap - 3.12.1	sow - 2.4.4
quenching stress - 3.7.11	scrap consignment - 3.12.38	specific heat capacity - 4.5.8
ramp ageing - 3.7.26	scrap for direct melting - 3.12.24	specimen - 4.1.7
razor streak - 5.5.8	scrap shipment - 3.12.39	speed cracks - 5.8.13
recrystallization - 4.5.21	scratch - 5.4.16	speed tear - 5.8.13
recrystallization annealing - 3.6.9	scratch-brushed finish - 3.10.12	spent blasting grit - 3.13.7
rectangular bar - 2.9.13	screw machine stock (SMS) -	spent caustic etching liquid -
rectangular bar - 2.9.13	2.9.25	3.13.22
recycled aluminium casting -	screw stock - 2.9.28	spent graphite parts (from melt
2.4.3	sealing - 3.8.16	treatment devices) - 3.13.6
recycled aluminium ingot - 2.4.3	seamless profile - 2.8.9	spent hardening salts - 3.13.24
recycled aluminium profile - 2.4.3	seamless tube - 2.8.17	spent hot rolling emulsion -
recycled aluminium strip - 2.4.3	secondary aluminium - 2.4.3	3.13.12
reeling (round rod/bar) - 3.4.17	section - 2.8.1	spent liquid metal filter material -
reeling (wire) - 3.4.18	segregation - 5.2.2	3.13.5
reeling marks - 5.8.9	self-stripping die - 3.4.8	spent machine oil - 3.13.16
refined aluminium - 2.1.3	semi-continuous casting - 3.1.6	spent mixed solvents - 3.13.25
refined aluminium alloy - 2.2.6	semi-finished product - 2.3.3	

spent roll grinding emulsion - 3.13.13	surface bloom - 5.6.4	turnings - 3.12.11
spider die - 3.4.8	surface segregation (unwrought product) - 5.2.7	twin columnar grains (TCG) - 5.2.13
spills - 3.12.9	telescoping – 5.3.17	twist - 4.4.9
splatters - 2.3.9	temper - 3.6.5	ultimate tensile strength - 4.3.3
spring back effect - 4.3.28	temper rolling - 3.3.5	ultrasonic test - 4.2.5
square bar - 2.9.12	tensile properties - 4.3.1	unalloyed aluminium - 2.1.2
squareness - 4.4.13	tensile strength - 4.3.3	under-ageing - 3.7.20
stabilizing; stabilization - 3.6.11	tensile test - 4.2.7	unwrought product - 2.3.1
step ageing - 3.7.25	tension levelling - 3.3.9	used aluminium packaging - 3.12.13
steriles - 3.12.27	tension scratches - 5.4.20	used beverage cans (UBC) - 3.12.12
sticking (of foil) - 5.9.5	test - 4.2.1	Vickers hardness, HV - 4.3.13
stop mark - 5.4.5	test piece - 4.1.8	visible surface - 3.10.16
stop mark 5.8.5	thermal stress relieving - 3.6.12	visual quality characteristic - 5.1.2
straightening - 3.4.16	thermal treatment - 3.6.1	volatile substance - 3.12.29
straightness - 4.4.1	thermo-mechanical processing - 3.2.5	waffles 2.2.11
strain - 3.2.9	tolerance - 4.4.22	waste coating materials - 3.13.18
strain hardening - 3.2.11	tolerance range - 4.4.23	waste water treatment residues - 3.13.10
strain mark - 5.9.6	tool - 3.4.6	water stain - 5.6.1
streak - 5.5.3	tooling plate - 2.6.16	water stain corrosion - 5.6.1
stress - 3.2.12	top side (of a sheet) - 2.6.19	wavy edges - 5.3.6
stress corrosion cracking - 5.6.16	torn surface - 5.8.7	welded tube - 2.8.18
stress relieving - 3.2.8	torsion test - 4.2.10	welding rod - 2.9.11
stretcher grip mark - 5.4.6	toughness - 4.3.18	welding wire - 2.9.23
stretcher jaw mark - 5.4.12	traded scrap - 3.12.5	wettability - 4.5.9
stretcher levelling - 3.3.8	traffic marks - 5.8.12	whip mark - 5.4.11
stretcher strain markings - 5.8.10	transfer period (quenching) - 3.7.14	wire - 2.9.16
stretching - 3.2.7	transverse arch - 4.4.5	workability - 4.3.16
striation - 5.7.7	transverse bow - 4.4.5	working - 3.2.2
stringer inclusions - 5.5.8	transverse direction - 4.1.12	wrapping test - 4.2.18
strip - 2.6.1	transverse extrusion seam - 3.4.14	wrought alloy - 2.2.7
strip casting - 3.1.5	tread plate - 2.6.30	wrought product - 2.3.2
stripes 5.5.3	trimming - 3.3.12	wrought scrap - 3.12.23
structural profile - 2.8.11	tube - 2.8.12	yield strength - 4.3.4
structural quality characteristics - 5.5.1	tube bloom - 2.8.19	yield strength $R_{p0.2}$ - 4.3.4
structural streak - 5.5.5	tube stock - 2.8.19	Young's modulus – 4.3.2
structural tube - 2.8.23	tumbling - 3.10.7	
super annealing - 3.6.10	turn-around scrap - 3.12.3	
superplastic forming - 3.5.8		
supplier - 3.11.8		

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