## FIELD OF APPLICATION

This technical specification is valid for all deliveries of aluminium peeled round billets ⌀40–⌀1245 mm.

## DISPATCH, DELIVERY, MATERIAL IDENTIFICATION

Each shipping box (max.: 1650 kg) is identified by:

* Its individual ID (number)
* The number of billets (chronological order according to production)

Each billet is identified by:

* The diameter
* The alloy/temper
* The date of production
* Production time
* Strand number

Each batch includes:

* Number of packed units (bundle/cassette; chronological order according to production)
* Diameter of the billet
* Alloy
* Date of production
* Production time
* Strand numbers

The inspection and delivery of the billets have to be carried out for each batch ID separately.

## TECHNICAL DEMANDS

### Chemical composition

Table 1 Chemical composition of alloy 6082

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Si: | 1.20–1.30 % | Mn: | 0.75–0.90 % | Zn: | max. 0.10 % |
| Fe: | max. 0.25 % | Mg: | 0.80–0.90 % | Ti: | 0,03-0,05 % |
| Cu: | 0.05–0.10 % | Cr: | 0.15–0.20 % | Zr: | 0,03-0,05 % |
| Na, Ca max. 0.0008 % | | Pb: | max. 0.0065 % | B: | max. 0,0050% |
| Cd, Bi, Sn, Sr: max. 0.010 % | |  |  |  |  |

Other elements (each): max. 0.05 %

Other elements (total): max. 0.15 %

H2 content: max. 0.13 ccm/100g

Table 2 Chemical composition of alloy 6110

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Si: | 0.85–0.95 % | Mn: | 0.45–0.50 % | Zn: | max. 0.05 % |
| Fe: | max. 0.20 % | Mg: | 0.75–0.85 % | Ti: | max. 0.04 % |
| Cu: | 0.45–0.50 % | Cr: | 0.17–0.24 % | Pb: | max. 0.0065 % |
| Zr: | max. 0.02 % | Na: | max. 0.0008 % | Cd: | max. 0.01 % |
| B: | max. 0.0050 % | Ca: | max. 0.0008 % | Bi: | max. 0.010 % |
| Sn: | max. 0.010 % | Sr: | max. 0.010 % |  |  |

Other elements (each): max. 0.05 %

Other elements (total): max. 0.15 %

H2 content: max. 0.13 ccm/100g

Table 3 Chemical composition of alloy 6110A

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Si: | 0.85–0.95 % | Mn: | 0.45–0.50 % | Zn: | max. 0.05 % |
| Fe: | max. 0.20 % | Mg: | 0.75–0.85 % | Ti: | 0.03–0.06 % |
| Cu: | 0.50–0.60 % | Cr: | 0.08–0.14 % | Pb: | max. 0.01 % |
| Zr: | 0.08–0.14 % | Bi: | max. 0.010 % | Cd: | max. 0.01 % |
| Sn: | max. 0.010 % | Sr: | max. 0.010 % |  |  |

Other elements (each): max. 0.05 %

Other elements (total): max. 0.15 %

Ti + Zr: max. 0.20 %

H2 content: max. 0.13 ccm/100g

Table 4 Chemical composition of alloy 6182

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Si: | 1.25–1.34 % | Mn: | 0.51–0.57 % | Zn: | max. 0.1 % |
| Fe: | 0.14–0.25 % | Mg: | 0.80–0.90 % | Ti: | 0.01–0.05 % |
| Cu: | 0.026–0.054 % | Cr: | 0.07–0.12 % | Pb: | max. 0.0065 % |
| Zr: | 0.14–0.18 % | Bi: | max. 0.010 % | Cd: | max. 0.01 % |
| B: | max. 0.0050 % | Sr: | max. 0.010 % | Sn: | max. 0.01 % |
| Na: | max. 0.0008 % | Ca: | max. 0.0008 % |  |  |

Other elements (each): max. 0.05 %

Other elements (total): max. 0.15 %

H2 content: max. 0.13 ccm/100g

### Metal quality

Grain size:

* Not exceeding a maximum of 120 µm; exception: no more than one single grain of less than 175 µm in analysed sample area. The analysed area of the sample is evaluated in the centre and at the edge of the billet.

Microstructure:

* Max. shell (peripheral) zone should not exceed 500 μm (not peeled).
* Secondary dendrite arm spacing: average < 20 µm
* Porosity (ISO 10049:2019): severity level 0 (1, 2, 3, 4, 5 and 6 are not acceptable)
* No cracks and pores are allowed under 50 X magnification. If cracks or pores are funded under 50 X magnification, the sample is NOK.
* Spinels, non-metallic inclusions or feather crystals are not allowed.
* In case of higher count of inclusions, only one cluster larger than 50 µm, or one agglomeration larger than 20 µm is acceptable within an area of 1 mm2. Limits for rough segregations, inclusions, oxides, salts, grain refiner particles are given in **Table 5**).

Table 5 Definitions and limits of inclusion types

|  |  |  |
| --- | --- | --- |
|  | **Length-to-width ratio** | **Size (µm)** |
| **Agglomeration** | *< 3* | 30 |
| **Cluster** | *≥ 3* | 100 |
| **Oxide film** | *-* | 30 |

*\*Cluster is defined as strings or grid of particles with a distance between the edges of the particles of no more than 3 µm. Agglomeration” is defined as compact group of particles with a distance between the edges of the particles of no more than 3 µm. Furthermore, agglomerations may be distinguished from clusters by the aspect ratio (Length/Width). Cluster: ≥ 3, Agglomeration: < 3.*

Microstructure examination:

A polished unetched sample surface will be examined for TiB/TiC, inclusions, porosity and other comparable inhomogeneities at a magnification of 50x. Metallographic images for a detailed documentation will be done at a magnification of 200x or more.

Minimum inspection frequency:

At least one sample from each strand per batch need to be analysed.

### Surface quality after peeling

Surface appearance – examined by visual control and surface roughness measurement.

A smooth, uniform surface is required after peeling as defined by the following:

* No remaining thick ribbed, serrated and / or sharp-edged contours.
* No remaining single spot defects and coherent zones of incomplete solidification
* No remaining irregular bandings or drags in billet casting direction (longitudinal)
* No remaining shell including the (inverse) segregation zone. Bergmann zones are generally not acceptable
* Surface roughness after peeling: Rz < 10 µm, locally single max. Rm 15 µm, Ra < 1,7 µm

Table 6 - Recommended Cut-off (ISO 4288-1996)



* Not allowed after peeling:

Inclusions, cold shuts, entrapped oxide skins, oxide releases with negative impact on the microstructure~~,~~ shark bites, tears transverse to the billet length, surface cracks, blisters, any impurities or mechanical damage, grinding.

### Dimensional tolerances

Length:

* Standard length of billet: 4500–6000 mm +6/-0 mm

Table 7 Tolerances of billet diameter

|  |  |
| --- | --- |
| **Billet diameter [mm]** | **Tolerances [mm]** |
| ≥45–55 | ±0,15 |
| >55–65 | ±0,15 |
| >65–80 | ±0,15 |
| >80–100 | ±0,15 |
| >100–120 | ±0,15 |
| ≥120 | ±0,15 |

Straightness (for diameter > 40 mm):

Saw angle: 90° ± 0,5°; saw burr < 0,2 mm

Max length of head (scrap) shall not be longer than 3 000 mm

Max length of tail (scrap) shall not be longer than 3 000 mm

According to DIN EN 754-3

Max. deviation: 2 mm/m

Max. deviation on overall length: 12 mm

### Non-destructive inspection

Ultrasonic testing (UST) of each billet has to be carried out according to ASTM 2375-08, (B594-13) acceptance class AA, puls-echo-method, vertical / radial acoustic irradiation, phased array testing technology, based on the following parameters:

* Clean, non-treated surface of the billet
* Inspection frequency: 10 MHz

Table 8 - Boundary conditions / validity

|  |  |  |  |
| --- | --- | --- | --- |
| ASTM B594-13 | Single Discontinuity | Multiple Discontinuities <1 inch | Multiple Discontinuities with 0.5 inch length |
| Class AA | 1,2 mm | 0,8 mm | 0,8 mm |

Operation instructions describing the specific performance of the ultrasonic inspection procedure have to be available at the inspection location.

Max. length of non-inspected part of billet shall not be longer than 20 mm for Ø40-84 mm from each side of the billet.

Max. length of non-inspected part of billet shall not be longer than 30 mm for Ø84-130 mm from each side of the billet.

Note: smaller untested ends might be possible but have to be validated during dynamic testing.

Defects open to surface cannot reliably detected.

Table 9 - Ultrasonic deadzone

|  |  |
| --- | --- |
| ASTM B594-13 | Dead zone in volume |
| Class AA | 2,0mm |

The dead zone is checked by means of eddy current testing and thus enables 100% volume testing.

Defects open to surface will be detected by eddy current testing.

### Mechanical properties

Round billets are manufactured and delivered in temper “as cast”.

## QUALITY MANAGEMENT

### Quality management system

Round billets as specified will be processed to suspension parts for the automotive industry. Therefore, the quality management system of the supplier has to fulfil the demands of IATF 16949 related to round billets.

### Inspection

By means of suitable quality inspections the supplier has to prove that the product properties of each delivery correspond to the requirements of the technical specification.

The following inspection have to be carried out and documented:

1. PoDFA: total max.: 0,05 mm2/kg, TiB2max.: 0,03 mm2/kg
2. Chemical analysis is done at the start of the batch, in the middle of the batch and at the end of batch
3. Every billet needs to be 100 % volumetric non-destructive tested inline
4. Inspection of the microstructure is done once per batch from each casting strand3), 4)
5. Dimensional inspection: length of billet, diameter, straightness
6. Visual control of billet surface; measurement of surface roughness

3) If the inspection result of only billet is negative all previously manufactured billets from the same strand within the same batch must be controlled until the defect disappearing.

4) For particular examinations the inspection frequency may differ from this term

## DOCUMENTATION

The documentation of process and product inspection including the duration of archiving has to be carried out under consideration of the quality standard VDA, volume 1.

A certificate of conformity, type 10204-3.1 B, containing the following information has to be attached to each batch:

* Order data, delivery volume
* Batch identification and actual corresponding chemical analysis, ultrasonic inspection, metallographical documentation of inner structure (s. 2.3.1), dimensional measurement, surface roughness measurement, mechanical properties.
* Explicit confirmation, that all prescribed were carried out. (suggestion: All required inspections based on these specification, especially ultrasonic testing, EDDY current and the analysis of the micro-structure of cast billets, were carried out. All billets fulfil the prescribed quality level)

## DISPATCH, DELIVERY, MATERIAL IDENTIFICATION

The delivery of billets has to be carried out separately according to batch identification.

A certificate of conformity is issued for each batch.

The correlation of the certicicate and the corresponding batch has to be ensured; the batch ID on the certification and on the label must be identical. Additionally, a label showing at least the batch ID, the unit ID, the alloy and the diameter is attached to each packed unit.

## DEFINITION OF “AS CAST” SURFACE DEFFECTS

Surface defects can occur during casting. The first measure is to cut off the affected strand at the casting machine. Peeling removes the casting surface.

* Incomplete liquation zone (LZ): coherent area of raised bumps originating from original solidified shell (bumps are subsurface to final liquated surface). Appearance mainly on the bottom surface (run out position, 180°).
* Dimple (DP): final stages of liquation leaving isolated locations (no coherent area)
* Oxide release (OR): Typical surface appearance is a bow or ring form covering the circumference partly or completely. Topography shows subsurface folds.
* Drag (DR): Typically, linear longitudinal scratch caused by mech. defect or particle. Typical topographies are surface / subsurface effects with sharp radii.

Obsah obrázku diagram, text, kruh, kresba

Popis byl vytvořen automaticky

Figure 1 - definition of "as cast" surface defects

|  |  |
| --- | --- |
|  |  |
| a) billet crack | b) peeled billet roughness is too high |
|  |  |
|  | |
| c) peeling failure, billets are not in touch during peeling | |

Fig. 2 examples of not allowed defects after peeling

## OTHER APPLICABLE NORM STANDARDS AND DOCUMENTS

|  |  |
| --- | --- |
| **SAF Packaging instructions** |  |
| **EN 515** | Aluminium and aluminium alloys – Wrought products – Temper designations |
| **EN 573** | Aluminium and aluminium alloys – Chemical composition and form of wrought products |
| **EN 604** | Aluminium and aluminium alloys – Cast forging stock |
| **ASTM E 2375** | Standard Practice for Ultrasonic Inspection of Aluminium – Alloy Wrought Products |
| **EN ISO 6506** | Metallic materials – Brinell hardness test |
| **EN ISO 6892** | Metallic materials – Tensile testing |
| **EN ISO 14001** | Environmental management systems – Requirements with guidance for use |
| **IATF 16949** | Quality management system requirements for automotive production and relevant service parts organisations |
| **DIN 50125** | Testing of metallic materials – Tensile test pieces |
| **VDA Band 6 ff.** |  |
| **REACH** | Registration, Evaluation, Authorization and Restriction of Chemicals (EU Directive) |
| **RoHS** | Restriction of Hazardous Substances (EU Directive) |
| **WEEE** | Waste of Electrical and Electronic Equipment (EU Directive) |

Explicit requirements and quantified limits as specified in this specification are superior to common norm standard definitions.