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Aluminium and aluminium alloys the sheet and strip for cans and caps of new energy power batteries

(English Translation)

（送审稿）

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FOREWORD

SAC/TC 243 is in charge of this English translation. In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.

This document is drafted in accordance with the rules given in the GB/T 1.1-2020 *Directives for standardization— Part 1: Rules for the structure and drafting of standardizing documents*.

This document replaces the GB/T 33824-2017 *Aluminium and aluminium alloys the sheet and strip for cans and caps of new energy power batteries*. In addition to a number of editorial changes, the following technical deviations have been made with respect to the GB/T 33824-2017.

— Modified terms and definitions (see Clause 3, Clause 3 of 2017 edition);
— Modified designations, temper and dimensions (see 4.1,4.1.1 of 2017 edition);
— Deleted the requirement for the elimination of prohibited elements (lead, cadmium)(see 4.2.2 of 2017 edition);
— Modified the requirement for dimensional tolerances(see 5.2, 4.3 of 2017 edition);
— Modified the requirements for tensile properties at room temperature(see 5.3,1,4.4 of 2017 edition);
— Added the requirements for tensile properties at high temperature(see 5.3.2);
— Modified the requirements for earing ratio(see 5.4, 4.5 of 2017 edition);
— Modified the requirements for Erishen value(see 5.5, 4.6 of 2017 edition);
— Deleted the requirements for laser welding performance(see 4.7 of 2017 edition);
— Added the requirements for conductivity(see 5.6);
— Added the requirements for thermal conductivity(see 5.7);
— Added the requirements for salt mist corrosion resistance performance(see 5.8);
— Added the requirements for microstructure(see 5.9);
— Modified the requirements for appearances (see 5.10, 4.8 of 2017 edition);
— Added the test methods for surface roughness(see 6.2);
— Added the test methods for conductivity(see 6.6);
— Added the test methods for thermal conductivity(see 6.7);
— Added the test methods for salt mist corrosion resistance(see 6.8);
— Added the test methods for microstructure(see 6.9);
— Deleted the test methods for laser welding performance(see 5.6 of 2017 edition);
— Added the test methods for height of burrs(see 6.10.1).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The issuing body of this document is not permitted held responsible for identifying any or all such patent rights.

This document was proposed by China Nonferrous Metals Industry Association.

This document was prepared by SAC/TC 243 National Technical Committee 243 on Nonferrous Metals of Standardization Administration of China.

This document was issued in 2017 as first edition,and first revised in 2025.

*A*luminium and aluminium alloys the sheet and strip for cans and caps of new energy power batteries

1 Scope

This document specifies classifications, technical requirements, test methods, qualification of products, process control, inspection rules, marking, packaging, transporting, storage and order (or contract) of Aluminium and aluminium alloys the sheet and strip for cans and caps of new energy power batteries.

This document is applicable to aluminium and aluminium alloy sheet(hereinafter referred to as sheet) and aluminium and aluminium alloy strip(hereinafter referred to as strip) for cans and caps of new energy power batteries .

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 2523 Measuring method of surface roughness, peak count and waviness for cold-rolled metal the sheet and strip

GB/T 3190 Chemical composition of wrought aluminium and aluminium alloys

GB/T 3199 Wrought aluminium and aluminium alloy products - Packing, marking, transporting and storing

GB/T 3246.1 Inspection method for structure of wrought aluminium , magnesium and their alloy Part1: Inspection method for microstructure

GB/T 3880.1 wrought aluminium , magnesium and their alloy plates, the sheet and strip for general engineering - Part1: Technical conditions for delivery

GB/T 3880.3-2024 wrought aluminium , magnesium and their alloy plates, the sheet and strip for general engineering - Part3: Tolerance on forms and dimensions

GB/T 4156 Metallic materials—the sheet and strip—Erichsen cupping test

GB/T 5125 Method for deep drawing cups testing of non-ferrous metals

GB/T 7999 Optical emission spectrometric analysis method of aluminium and aluminium alloys

GB/T 8005.1 Aluminium and aluminium alloy terms and definitions- Part 1: Product and method of processing and treatment

GB/T 12966 The methods for determining aluminium and aluminium alloys conductivity using eddy current

GB/T 16865 Test pieces and methods for tensile test for wrought aluminium , magnesium and their alloy

GB/T 17432 Methods for sampling for analyzing the chemical composition of wrought aluminium and aluminium alloys

GB/T 20975(All parts) Methods for chemical analysis of aluminium and aluminium alloys

GB/T 22588 Determination of thermal diffusivity or thermal conductivity by the flash method

GB/T 26492.3 Defects for wrought aluminium and aluminium alloys ingots and products - Part 3:Defects for plates,the sheet and strip
GB/T 42916 Identification marking of aluminium and aluminium alloy products

3 Terms and definitions

For the purposes of this document,the terms and definitions given in GB/T 8005.1 and GB/T 26492.3 apply.

4 Classification

4.1 Designations, temper and dimensions

The designations, temper and dimensions of the sheet and strip shall be as specified in Table 1. Other designations, temper and dimensions (if required) shall be agreed between the purchaser and the supplier, and stated in order(or contract).

Table 1 Designations, temper and dimensions

Designations	Temper	Dimensions mm		
		Thickness of the sheet and strip	Width of the sheet and strip	Length of the sheet
1050	O、H24、H18	0.20～3.00	20.0～500.0	—
1050A	O	0.20～0.50	200.0～500.0	—
1060	O、H14、H18	0.20～4.00	20.0～1300.0	—
3003	O、H14、H24、H18	0.20～4.00	20.0～1800.0	900.0～1100.0
5083	O	0.50～1.50	100.0～1500.0	—
8014	O	0.30～0.50	20.0～1000.0	—

4.2 Marking

The marking shall be expressed in the order of product name, this document number, designation, temper and dimensions.

Example 1:

Sheet with designation 3003, temper H14, 0.50mm in thickness, 314.0mm in width and 1032.0mm in length is marked as:

Sheet GB/T 33824-3003H14-0.50×314.0×1032.0

Example 2:

Strip with designation 1060, temper O, 1.00mm in thickness and 1260.0mm in width is marked as:

Strip GB/T 33824-1060O-1.00×1260.0

5 Technical requirements

5.1 Chemical composition

The chemical composition of product shall conform to the requirements in GB/T 3190. When the purchaser has special requirements, they shall be agreed between the purchaser and the supplier, and stated in order (or contract).

5.2 Dimensions

5.2.1 Thicknesses

Thickness of the sheet and strip shall be in accordance with high precision grade in GB/T 3880.3-2024.

5.2.2 Width

Width of the sheet and strip shall be as specified in Table 2, When the purchaser has special requirements, they shall be agreed between the purchaser and the supplier, and stated in order(or contract). The tolerances on width shall be twice the corresponding value given in Table 2, if unidirectional tolerances (either plus or minus) on width of the sheet and strip is required by the purchaser.

Table 2 Tolerances on width

Unit in millimeter

Width	Tolerance on width
20.0～500.0	±0.2
＞500.0～1000.0	±0.5
＞1000.0～1500.0	±1.0
＞1500.0～1800.0	±1.5

5.2.3 Length

Length of the sheet shall be in accordance with high precision grade in GB/T 3880.3-2024.

5.2.4 Flatness tolerance

For sheets in non-O temper, the warpage height at the end of the sheet shall be less than 10mm. The flatness of other parts of the sheet shall be in accordance with high precision grade in GB/T 3880.3-2024. If the purchaser has requirements on the flatness tolerance of the sheet and strip with temper O, they shall agreed between the purchaser and the supplier, and stated in order(or contract).

5.2.5 Lateral curvature

Lateral curvature of the sheet and strip shall be in accordance with high precision grade in GB/T 3880.3-2024.

5.2.6 Diagonal

The length of diagonal shall be in accordance with high precision grade in GB/T 3880.3-2024.

5.2.7 Surface roughness

When the purchaser has requirements for surface roughness (R_a), they shall agreed between the purchaser and the supplier, and stated in order(or contract).

5.2.8 Oscillation and telescoping

The strip is permitted to have oscillations of no more than 1mm and a telescoping of no more than 5mm(excluding the innermost five coils and outermost three coils).

5.3 Tensile properties

5.3.1 The longitudinal tensile properties of the sheet and strip at room temperature shall be as specified in Table 3. When the purchaser has special requirements for tensile properties at room temperature, they shall be agreed between the purchaser and the supplier, and stated in order(or contract).

Table 3 Tensile properties at room temperature

Designations	Temper	Thicknesses mm	The tensile testing results at room temperature		
			Tensile strength (R_m) MPa	0.2 % proof stress ($R_{p0.2}$) MPa	Elongation (A_{50}) %
1050	O	0.20～0.50	60～100	≥20	≥30.0
		>0.50～0.80			≥40.0
		>0.80～1.50			
		>1.50～3.00			
	H18	>0.50～1.50	≥130	—	≥4.0
	H24	>0.80～1.50	95～140	≥75	≥8.0
		>1.50～3.00			
1050A	O	0.20～0.50	65～95	≥20	≥30.0
1060	O	0.20～0.30	55～95	≥15	≥15.0
		>0.30～0.50			≥20.0
		>0.50～1.50			≥30.0
		>1.50～3.00			≥35.0
	H14	0.80～1.50	95～130	≥75	≥6.0
		>1.50～3.00			≥8.0
	H18	0.50～1.50	≥125	≥85	≥4.0
		>1.50～3.00			≥5.0
		>3.00～4.00			≥6.0
3003	O	0.20～0.50	95～135	≥35	≥20.0
		>0.50～1.50			≥25.0
		>1.50～3.00			≥30.0
	H14	0.20～0.50	140～175	≥125	≥4.0
		>0.50～1.50			≥4.0
		>1.50～3.00			≥5.0
		>3.00～4.00			≥6.0

	H24	0.20～0.50	145～195	≥115	≥6.0
	H18	0.20～0.50	≥190	≥170	≥2.0
		>0.50～1.50			≥2.0
		>1.50～3.00			≥4.0
5083	O	0.50～1.50	275～350	≥125	≥17.0
8014	O	0.30～0.50	100～140	≥35	≥32.0

5.3.2 When the purchaser has requirements for tensile properties at high temperature, they shall be agreed between the purchaser and the supplier, and stated in order(or contract).

5.4 Earing ratio

Earing ratio of the sheet and strip with designation 3003 for battery case shall be as specified in Table 4.When the purchaser has requirements for earing ratio of the sheet and strip with designation 1050 or 1060, they shall be agreed between the purchaser and the supplier, and stated in order(or contract).

Table 4 Earing ratio

Designations	Temper	Thicknesses mm	Earing ratio (e) %
3003	H14	0.60～3.00	≤4.5

5.5 Erishen value

Erishen value of the sheet and strip with designation 3003 for battery case shall be as specified in Table 5.When the purchaser has requirements for erishen value of the sheet and strip with designation 1050 or 1060, they shall be agreed between the purchaser and the supplier, and stated in order(or contract).

Table 5 Erishen value

Designations	Temper	Thicknesses mm	Erishen value (IE) mm
3003	O	0.60～1.50	≥8.00
		>1.50～3.00	≥10.00
	H114	0.60～1.50	≥7.50
		>1.50～3.00	≥8.00

5.6 Conductivity

When the purchaser requests the conductivity of the sheet and strip for soft connection, it should be specified in order(or contract), and the supplier shall provide the test results of the conductivity.

5.7 Thermal conductivity

When the purchaser requests the thermal conductivity of the sheet and strip, they shall be specified in order(or contract), and the supplier shall provide the test results of the thermal conductivity.

5.8 Salt mist corrosion resistance performance

When the purchaser has requirements for salt mist corrosion resistance performance of the sheet and strip for battery case, cover and side panel, they shall be specified in order(or contract), and the supplier shall provide the test results of the salt mist corrosion.

5.9 Microstructure

5.9.1 When the purchaser has requirements for grain size, they shall be agreed between the purchaser and the supplier, and stated in order(or contract).

5.9.2 When the purchaser or the supplier have disputes over the measurement results of the earing ratio or the erishen value, the texture can be measured and the test results should be provided. Annex A gives examples of the texture results corresponding to different earing ratio for the sheet and strip.

5.10 Appearances

5.10.1 The height of burrs on the edge of strip should not exceed the smaller value between 4%·T (where T is the nominal thickness) and 0.045mm.

5.10.2 Other surfaces requirements of the sheet and strip shall be in accordance with GB/T 3880.1.

6 Test methods

6.1 Chemical composition

Chemical composition analysis of the sheet and strip shall be carried out as specified in GB/T 20975 or GB/T 7999. Arbitration analysis shall be carried out as specified in GB/T 20975.

6.2 Dimensional tolerances

Surface roughness measurement shall be carried out as specified in GB/T 2523, other dimensional tolerances shall be carried out as specified in GB/T 3880.3-2024.

6.3 Tensile properties at room temperature

Tensile test shall be carried out as specified in GB/T 16865.

6.4 Earing ratio

Earing ratio test shall be carried out as specified in GB/T 5125.

6.5 Erishen value

Erishen value test shall be carried out as specified in GB/T 4156.

6.6 Conductivity

Conductivity test shall be carried out as specified in GB/T 12966.

6.7 Thermal conductivity

Thermal conductivity test shall be carried out as specified in GB/T 22588.

6.8 Salt mist corrosion resistance performance

The test method of salt mist corrosion resistance performance shall be agreed between the purchaser and the supplier, and stated in order(or contract).

6.9 Microstructure

Grain size measurement shall be carried out as specified in GB/T 3246.1.The test method of texture see Annex B.

6.10 Appearance

6.10.1 Height of burrs

Select the cutting edge positions on both sides of the strip. Cut a sample along the cutting edge, including the edge of the strip's cutting edge. The length of the sample shall be greater than 30cm. Use the corresponding precision measuring tools to measure the distance from the tip of the burr to the edge of the sample. If necessary, measurements can be made using an image measuring instrument or a microscope.

6.10.2 Other appearance

Other appearance test shall be carried out as specified in GB/T 3880.1.

7 Inspection rules

7.1 Inspection and acceptance

7.1.1 Products shall be inspected by technical supervision departments to ensure the products conform to this document and the order (or contract). A quality certificate shall be filled out accordingly.

7.1.2 Inspection of the received products shall be carried out by the purchaser in accordance with the requirements of this document.In case of non-conformity with the requirements of this document or with the stipulations of order (or contract), the purchaser shall make complaints in writing to the supplier for a solution which shall be discussed and agreed between the two parties.Complaints of non-conformity concerning deviations of surface quality or dimensions shall be made within one month after the date of receiving the products; complaints of non-conformity concerning other properties shall be made within three months after the date of receiving the products.In case of arbitration, sampling shall be carried out by both parties.

7.2 Batches

Inspection and acceptance shall be carried out in batches. Each batch shall consist of products with the same designations, temper and dimensions.There is no limit on the quantity per batch.

When the purchaser has requirements for batches, they shall be agreed between the purchaser and the supplier, and stated in order(or contract).

7.3 Weight calculation

Products shall be calculated by net weight.

7.4 Inspection items and process assureditems

When there is no special requirements in order (or contract), the ex-works inspection items, Regular inspection items and process assured items shall be in accordance with able 6.Regular inspections shall be conducted at least once per year.

Table 6 Inspection items and process assured items

Inspection items		Ex-works inspection	Regular inspection	Process assured
Chemical composition		√	—	—
Dimensional tolerances		√	—	—
Tensile properties	At room temperature	√	—	—
	At high temperature	—	—	√
Earing ratio		—[a]	—	√
Erishen value		—[a]	—	√
Conductivity		—	—	√
Thermal conductivity		—	—	√
Salt mist corrosion resistance performance		—	—	√
Microstructure	Grain size	—	√	√
	testure	—	—	√
Apperances		√	—	—
Note: “√” means “inspection items or process assured items”; “–” means “non-inspection items”.				
[a]It is Ex-works inspection for the sheet and strip with designation 3003 for battery case.				

7.5 Sampling

Sampling for the inspection items shall be in accordance with Table 7.

Table 7 Sampling

Inspection items		Sampling requirements
Chemical composition		Sampling shall be carried out according to GB/T 17432
Dimensional tolerances	Surface roughness	Select at least 1 sample in each batch,other requirements shall be in accordance with GB/T 2523
	Others	Select 3 sheets in each sheet batch for inspection, the strip shall be inspected one by one

Tensile properties	At room temperature	For each item, randomly select 2% of the coils (not less than 2 coils in each furnace) in each batch, take 3 test pieces at each coil; randomly select 2% of the total number of sheets (not less than 3 pieces) in each batch, take 1 test pieces at each sheet
	At high temperature	
Earing ratio		Randomly select 2% of the coils (not less than 2 coils in each furnace) in each batch, take 3 earing ratio samples and 3 erishen value samples at each coil; randomly select 2% of the total number of sheets (not less than 3 pieces) in each batch, take 1 sample for each item at each sheet
Erishen value		
Conductivity		Randomly select 1 sample in each batch
Thermal conductivity		Randomly select 1 sample in each batch
Salt mist corrosion resistance		Randomly select 1 sample in each batch
Microstructure	Grain size	Randomly select 1 sample in each batch
	Texture	Randomly select 1 sample in each batch
Appearance	Height of burrs	Randomly select 2 coils in each batch, take 2 samples at each coil for inspection
	Others	Inspect each piece (coil)

7.6 Determination of inspection results

7.6.1 If any specimen fails in terms of chemical composition and the casting melts can be distinguished, the casting batch represented by the specimen shall be deemed not to conform to the requirements of this document, then the other casting melts shall be checked one by one, and only the qualified coils shall be delivered. If the cast melts cannot be distinguished, the whole batch shall be deemed not to conform to the requirements of this document.

7.6.2 If any specimen fails in terms of surface roughness, specimen in double quantity shall be taken from the coils of the same batch for retesting. If all specimen for retesting meet the requirements for surface roughness, the corresponding batch shall be deemed to qualified. If any of these specimen fail to meet the requirements for surface roughness, the batch shall be deemed unqualified. If any sheet does not meet the requirements for dimensional tolerances, the product shall be deemed unqualified, the sheets of this batch can be inspected one by one by the supplier after agreement between the purchaser and the supplier, and only the qualified sheets shall be delivered. If any strip does not meet the requirements for dimensional tolerances, the product shall be deemed unqualified.

7.6.3 If any test piece does not meet the requirements for tensile properties at room temperature, test pieces in double quantity shall be taken from the product (including the product represented by the unqualified test piece in first sampling) of the same batch (heat treatment furnace) for retesting. If all these test pieces for retesting meet the requirements for tensile properties, the corresponding batch shall be deemed to qualified. If any of these test pieces fail to meet the requirements for tensile properties, the batch shall be deemed unqualified. The sheet(coil or furnace) of this batch can be tested one by one by the supplier after agreement between the purchaser and the supplier, and only the qualified coils shall

be delivered.the supplier is also allowed to repeated heat treatment and re-sample for inspection.

7.6.4 If any specimen does not meet the requirements for earing ratio, specimen in double quantity shall be taken from the product of the same batch (heat treatment furnace) for retesting. If all these specimens for retesting meet the requirements for earing ratio, the corresponding batch shall be deemed to qualified. If any of these specimens fail to meet the requirements for earing ratio, the batch shall be deemed unqualified. The sheet(coil or furnace) of this batch can be tested one by one by the supplier after agreement between the purchaser and the supplier, and only the qualified coils shall be delivered.the supplier is also allowed to repeated heat treatment and re-sample for inspection.

7.6.5 If any specimen does not meet the requirements for erishen value, specimen in double quantity shall be taken from the product of the same batch (heat treatment furnace) for retesting. If all these specimens for retesting meet the requirements for erishen value, the corresponding batch shall be deemed to qualified. If any of these specimens fail to meet the requirements for erishen value, the batch shall be deemed unqualified. The sheet(coil or furnace) of this batch can be tested one by one by the supplier after agreement between the purchaser and the supplier, and only the qualified coils shall be delivered.the supplier is also allowed to repeated heat treatment and re-sample for inspection.

7.6.6 If any specimen does not meet the requirements for grain size, specimen in double quantity shall be taken from the product of the same batch for retesting. If all these specimens for retesting meet the requirements for grain size, the corresponding batch shall be deemed to qualified. If any of these specimens fail to meet the requirements for grain size, the batch shall be deemed unqualified.

7.6.7 If any specimen does not meet the requirements for height of burr, specimen in double quantity shall be taken from the product of the same batch for retesting. If all these specimens for retesting meet the requirements forheight of burr, the corresponding batch shall be deemed to qualified. If any of these specimens fail to meet the requirements for height of burr, the batch shall be deemed unqualified. The coil of this batch can be tested one by one by the supplier after agreement between the purchaser and the supplier, and only the qualified coils shall be delivered.If any product does not conform to the requirements for other appearance, the sheet(coil) shall be deemed not to conform to the requirements of this document.

8 Marking, packaging, transporting, storage and quality certification

8.1 Identification marking

Identification marking of product shall be as specified in GB/T 42916.

8.2 Packaging, transporting and storage

8.2.1 The sheet and strip are not packed with paper. If the purchaser requests paper padding, film coating or oil application, it should be stated in order (or contract) form as "paper padding", "film coating" or "oil application".

8.2.2 Other requirements of the packaging, transporting and storage of the products shall be as specified in GB/T 3199.

8.3 Quality certificate

Each batch foils shall be delivered with a product quality certificate (To ensure the validity of the relevant inspection documents, the quality certificate may not be provided along with the products) with the following information stated.

a) The supplier;
b) Product name;
c) Designation and temper;
d) Dimension;
e) Batch or coil number;
f) Net weight or number of (sheet) or coil;
g) Inspection result of various analysis items;
h) This document number;
i) Inspection stamp of the supplier's technical supervision departments;
j) Date of packaging (or date of ex-works).

9 Order (or contract)

Order for the products listed in this document shall contain the following information:

a) Product name,
b) Designations, temper,
c) Dimensions,
d) Net weigh (or number of sheets),
e) When ordering the strip, indicate whether it comes with a core, the inner diameter of the core, and the material of the core.
f) Special requirements from the purchaser:
- Special requirements of designations, temper and dimensions,
- Special requirements of dimensional tolerances,
- Special requirements of tensile properties,
- Require test of conductivity,
- Require test of thermal conductivity
- Require test of salt mist corrosion resistance performance and the conditions.
- Require test of grain size,
- Require paper padding, film coating or oil application,
- Other special requirements.

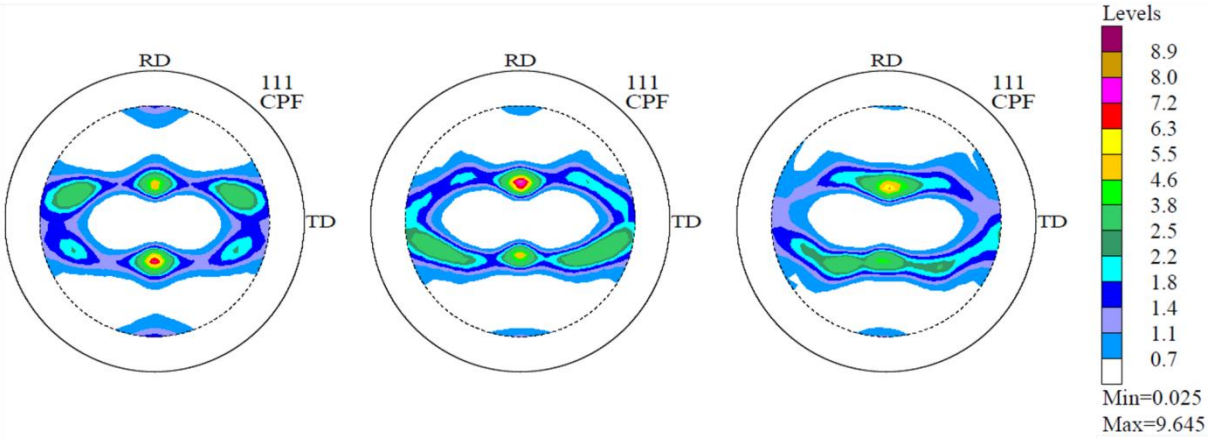
g) This document number.

Annex A
(Informative)
Examples of texture analysis results for sheet and strip

A.1 Examples of texture test results corresponding to different earing rates for 3003H18 sheet and strip are given in Table A.1 and Figure A.1.

Table A.1 Texture test results for 3003H18 sheet and strip with different earing rates

Thickness (mm)	Earing rate %	Texture components test results								Corresponding pole figure
		Cube %	Goss %	Brass %	S %	Copper %	CG %	BSC %	CG/BSC	
1.47	7.3	2.98	3.35	12.08	26.99	24.20	6.33	63.27	0.100	See Figure A.1a)
1.43	7.4	3.78	1.99	14.19	32.15	21.31	5.77	67.65	0.085	See Figure A.1b)
1.37	7.9	4.54	3.88	18.39	29.15	15.42	8.42	62.96	0.134	See Figure A.1c)



a) Earing rate 7.3%　　b) Earing rate 7.4%　　c) Earing rate 7.9%

Key

RD　Rolling direction

TD　Transverse direction

111CPF　Corrected pole figure of (111) crystal plane

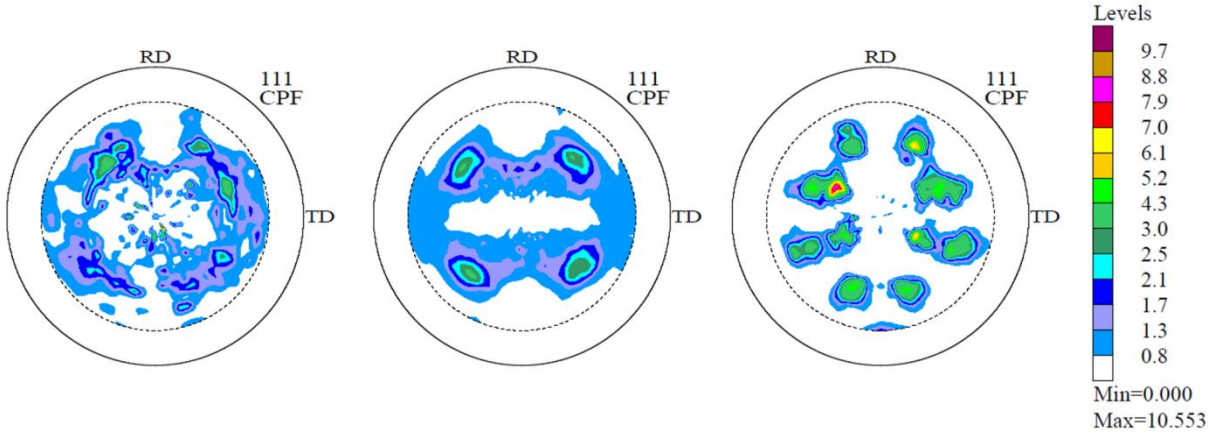
Figure A.1 Examples of texture pole figures for 3003H18 sheet and strip with different earing rates

A.2 Examples of texture test results corresponding to different earing rates for 3003O sheet and strip are given in Table A.2 and Figure A.2.

Table A.2 Texture test results for 3003O sheet and strip with different earing rates

Thickness (mm)	Earing rate %	Texture components test results								Corresponding pole figure
		Cube %	Goss %	Brass %	S %	Copper %	CG %	BSC %	CG/BSC	
1.37	1.8	19.92	5.35	4.74	14.21	6.30	25.27	25.25	1.001	See Figure A.2a)

1.43	2.3	19.56	5.62	6.76	14.28	6.09	25.18	27.13	0.928	See Figure A.2b)
1.47	4.0	16.13	1.82	3.71	4.74	1.51	17.95	9.96	1.800	See Figure A.2c)



a) Earing rate 1.8%　　b) Earing rate 2.3%　　c) Earing rate 4.0%

Key

RD　　Rolling direction

TD　　Transverse direction

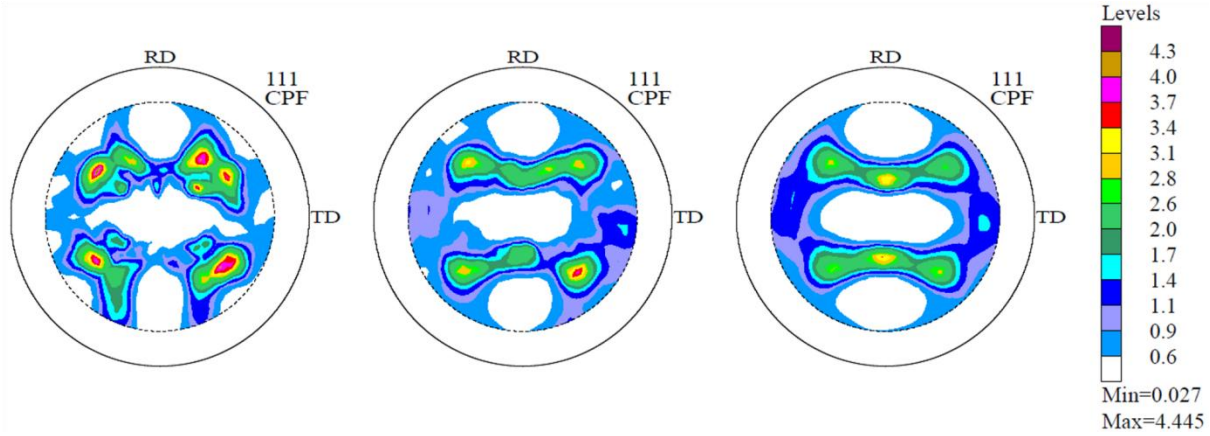
111CPF　　Corrected pole figure of (111) crystal plane

Figure A.2 Examples of texture pole figures for 3003O sheet and strip with different earing rates

A.3 Examples of texture test results corresponding to different earing rates for 3003H14 sheet and strip are given in Table A.3 and Figure A.3.

Table A.3 Texture test results for 3003H14 sheet and strip with different earing rates

Thickness (mm)	Earing rate %	Texture components test results								Corresponding pole figure
		Cube %	Goss %	Brass %	S %	Copper %	CG %	BSC %	CG/BSC	
2.00	1.9	25.86	3.55	6.79	9.60	5.62	29.41	22.01	1.340	See Figure A.3a)
1.00	2.5	17.89	7.04	7.94	15.68	7.46	24.93	31.08	0.802	See Figure A.3b)
1.00	2.8	13.88	6.94	9.86	19.22	10.25	20.82	39.33	0.529	See Figure A.3c)



a) Earing rate 1.9%　　b) Earing rate 2.5%　　c) Earing rate 2.8%

Key

RD	Rolling direction
TD	Transverse direction
111CPF	Corrected pole figure of (111) crystal plane

Figure A.3 Examples of texture pole figures for 3003H14 sheet and strip with different earing rates

Annex B
(Informative)
Texture test method for sheet and strip

B.1 Principle

The intensity of the diffraction peak at a given diffraction angle is related to the total amount of crystal planes in the grains. By measuring the intensity of diffraction signals at various spatial angles, the distribution state of grains in space can be calculated to obtain pole figures, which are then converted into orientation distribution function (ODF) diagrams to calculate the content of different texture types.

B.2 Apparatus

X-ray diffractometer, including:
— Main unit: 2θ angular resolution better than 0.02°. Sample stage capable of tilting in two angles (α, β), with α range 0°-75° and β range 0°-360°, angular resolution better than 0.1°. Copper target is recommended for X-ray source.
— Incidence optical path: Orthogonal optical system, spot size adjustable from 0 mm to 8 mm in both transverse and longitudinal directions, minimum spot size 2 mm. Nickel filter shall be used to filter K_β radiation (may be placed in diffracted beam path).
— Diffraction optical path: Parallel beam collimation system with Soller slit, preferably 0.04 rad

B.3 Reference samples and test specimens

B.3.1 Reference sample

Prepare texture-free reference sample by compacting pure aluminum or aluminum alloy powder using plasma sintering (sintering temperature ≤520℃, pressure ≥30 MPa) or cyanoacrylate adhesive bonding (porosity ≤5%) for defocusing correction.

B.3.2 Test specimen

Specimen shall be square or circular with thickness ≤10mm. For materials thicker than 10mm, reduce thickness by milling while retaining one original surface. Side length or diameter shall be more than 10 times the spot size

B.4 Test procedure

B.4.1 Open all detector units of the X-ray diffractometer. The sum of counts from all units shall be used as the intensity at any spatial angle.
B.4.2 Place reference sample on the stage for phase analysis. Signal-to-noise ratio of strongest peak should be more than 10, 2θ angle should be in the accuracy of 0.01°.
B.4.3 Collect tilt angle α data at intervals of 5° or 2.5°, from 0° to 70° or 75°. Collect in-plane angle β data at intervals of 5° or 2.5°. Select the continuous collection mode for diffraction intensity, at each fixed α, sum the diffracted intensities over β rotation as the diffraction value for that spatial angle. Integration time should not be shorter than 1s per point. Record intensities $I_{S2\theta}(\alpha, \beta)$ at 2θ angle diffraction peaks on (111), (200) and (220) plane, and the intensities $I_{SB}(\alpha, \beta)$ at 3° angle diffraction peaks.
B.4.4 Place the test specimen on the stage and test the specimen following B.4.2 and B.4.3, to obtain $I_{C2\theta}(\alpha, \beta)$ and $I_{CB}(\alpha, \beta)$.

B.5 Data processing

B.5.1 Pole figure plotting

Calculate each collected pole figure value $P(a,\ \beta)$ according to Equation (B.1). Plot corrected pole figure (CPF) using left-hand rule with contour lines not less than 10. Ad the examples shown in Annex A.

$$P(\alpha,\beta)=\frac{I_{S2\theta}(\alpha,\beta)-I_{SB}(\alpha,\beta)}{I_{C2\theta}(\alpha,\beta)-I_{CB}(\alpha,\beta)} \quad \text{(B.1)}$$

Where:

$I_{S2\theta}(a,\ \beta)$ is diffraction intensity of reference sample at Bragg angle on (111), (200) and (220) plane;

$I_{SB}(a,\ \beta)$ is diffraction intensity of reference sample above 3° Bragg angle on (111), (200) and (220) plane;

$I_{C2\theta}(a,\ \beta)$ is diffraction intensity of test specimen at Bragg angle on (111), (200)and (220) plane;;

$I_{CB}(a,\ \beta)$ is diffraction intensity of test specimen above 3° Bragg angle on (111), (200) and (220) plane.

Round results to integers according to GB/T 8170

B.5.2 ODF plotting

B.5.2.1 Define the sample rolling direction (RD), normal direction (ND) and transverse direction (TD) as common coordinate system, and the crystallographic axes [100]、[010] and [001] as cubic crystal coordinate system.The two coordinate systems shall coincide at their initial orientation. The spatial orientation of any crystal grain can be represented by a set of Euler angles (ϕ_1, Φ, ϕ_2), where the three angles correspond to sequential rotations of the crystal lattice.The sample coordinate system shall be selected with orthorhombic symmetry, and the arbitrarily defined cells method is recommended for polor coordinate transformation to Euler agnles.

B.5.2.2 Take multiple equidistant sections perpendicular to a selected Euler angle axis in the orientation space, with a recommended interval of 5° . Plot the orientation distribution function on each section plane, preferably by sectioning along the ϕ_2 axis, and present as two-dimensional contour plots

B.5.3 Texture content calculation

B.5.3.1 The content of six texture components shall preferably be calculated using either the direct integration method or Gaussian/Lorentzian function fitting method. The Euler angle tolerance may be selected as (±10° , ±10° , ±10°) or (±15° , ±15° , ±15°).

B.5.3.2 The CG value is defined as the sum of the Cube and Goss texture contents and the BSC value is defined as the sum of the Brass, S, and Copper texture contents.

B.5.3.3 The CG/BSC value is defined as the ratio of CG and BSC value.

B.6 Test reports

The test reports shall contain the following:

a) Sample identification;

b) Alloy designation and temper;

c) Dimensions;
d) The document number of this document;
e) Test conditions (instrument model, software, Euler angle tolerance);
f) Results (pole figures, ODF diagrams, texture types and contents);
g) Date;
h) Operator.

Reference

[1] GB/T 8170 Rules of rounding off for numerical values & expression and judgement of limiting values