

Information about the content

| | | | |
|--------------------------|-------------|--------------------------|-------------|
| Responsible area: | Plansee SE | Prepared/Updated: | See SAP-DMS |
| Valid from: | 05-Mar-2021 | Released: | See SAP-DMS |
| | | Controlled: | PSE-020 |

This document is subject to electronic version control – confirm revision status before using.

This specification covers hot- and cold-rolled Mo-sheets, which are suited i.e. for deep-drawing (thickness 0,10 – 3 mm), spinning (0,5 – 10 mm) or mechanical finishing (0,1 – 50 mm), including sheet cuts.

1 Dimensions and tolerances

1.1 Thickness and width tolerances

Cold rolled sheets

| Thickness [mm] | Thickness tolerance [mm or % of the thickness] | Maximal width [mm] | Width tolerance [mm] |
|------------------|--|--------------------|----------------------|
| 0,10 | ± 0,008 | 305 | ± 0,5 |
| > 0,10 – < 0,127 | ± 0,010 | 305 | ± 0,5 |
| 0,127 – ≤ 0,15 | ± 0,010 | 610 | ± 0,5 |
| > 0,15 – < 0,25 | ± 0,015 | 800 | ± 0,5 |
| 0,25 – ≤ 0,50 | ± 0,020 | 915 | ± 0,8 |
| > 0,50 – ≤ 0,80 | ± 0,028 | 915 | ± 0,8 |
| > 0,80 – ≤ 1,20 | ± 0,035 | 915 | ± 0,8 |
| > 1,20 – 2,00 | ± 3 % | 915 | ± 0,8 |

Hot rolled sheets

| Thickness [mm] | Thickness tolerance [mm or % of the thickness] | Maximal width [mm] | Width tolerance [mm] |
|-----------------|--|--------------------|----------------------|
| 1,00 | ± 0,080 | 850 | ± 2,0 |
| > 1,00 – ≤ 1,50 | ± 0,130 | 850 | ± 2,0 |
| > 1,50 – ≤ 2,00 | ± 0,150 | 850 | ± 2,0 |
| > 2,00 – ≤ 3,60 | ± 0,180 | 1200 | ± 2,0 |
| > 3,60 – 7,00 | ± 5 % | 1500 | ± 2,0 |
| > 7,00 – 20,00 | ± 5 % | 1300 | ± 2,0 |
| > 20 – 50,00 | ± 5 % | 1000 | ± 2,0 |

1.2 Length tolerance

The length tolerance for sheet length up to 2500 mm is max. + 5 / - 0 mm.

The maximum sheet dimensions depend on the sheet thickness. Other dimensions upon request.

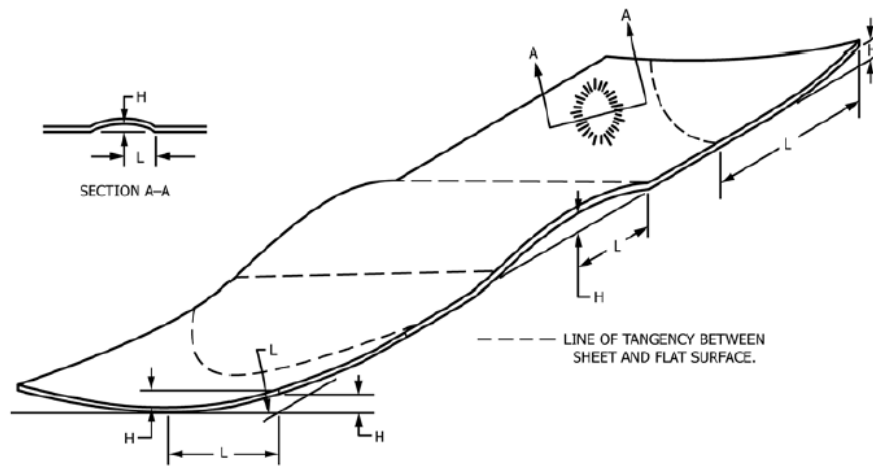
Sheets with thickness from 0,127 to 0,381 mm can be delivered as coils upon request (production length max. 10500 mm).

1.3 Flatness

Flatness: max. 1 % for sheet thickness ≥ 0,3mm
max. 4 % for sheet thickness < 0,3mm

Mo-Sheet

(measuring procedure on the basis of ASTM B386)



Flatness Deviation, % = $(H/L) \times 100$

H = maximum distance between flat surface and lower surface of sheet.

L = minimum distance between highest point on sheet and point of contact with flat surface.

1.4 Sheet cuts

These cuts are being produced from the sheets described in (1.1).

a) Tolerances for sheet cuts:

Thickness \leq 15 mm: DIN-ISO 2768 Part 1 Tolerance class m (medium)
 Thickness $>$ 15 mm: DIN-ISO 2768 Part 1 Tolerance class c (coarse)

b) Flatness:

The same specified limits as defined for sheets (see 1.3) apply for the sheet cuts.

c) Proportion of length to width:

The length and/or the width must in any case exceed the thickness, maximal width 1000 mm.

| Length [mm] | Minimal width [mm] |
|-----------------|--------------------|
| 20 - 400 | 20 |
| $>$ 400 - 1000 | 40 |
| $>$ 1000 - 2000 | 60 |

d) Discs and Rings:

Stated below, minimal ring width, minimal hole diameter 3 mm.

| Diameter* [mm] | Minimal width for rings [mm] |
|----------------|------------------------------|
| \geq 15 - 50 | 4 |
| $>$ 50 - 100 | 10 |
| $>$ 100 - 500 | 15 |
| $>$ 500 - 1000 | 20 |

* Diameter for discs, external diameter for rings

Other dimensions on request.

2 Physical and mechanical product properties

2.1 Product properties

| | | |
|--|--------------------------|------------------|
| Density: ^a | ≥ 10,2 g/cm ³ | |
| Vickers hardness: ^{b)} | Thickness in mm | Vickers hardness |
| | ≤ 1,00 | 240 - 280 |
| | > 1,00 – ≤ 3,60 | 240 - 270 |
| | > 3,60 - ≤ 10,00 | 220 - 270 |
| | > 10,00 - 50,00 | > 200 |

| | | | | |
|------------------------------------|-------------------|-----------------------------------|--|---------------------------|
| Tensile Test: ^{c)} | Thickness [mm] | Tensile strenght min. [MPa] | 0,2 % Yield strenght min. [MPa] | Elongation min. [%] |
| | 0,10 – ≤ 0,25 | 700 | 620 | 2,0 |
| | > 0,25 – ≤ 0,40 | 680 | 590 | 3,0 |
| | > 0,40 – ≤ 0,65 | 680 | 590 | 5,0 |
| | > 0,65 – ≤ 1,50 | 680 | 590 | 10,0 |
| | > 1,50 – ≤ 2,30 | 640 | 580 | 12,0 |
| | > 2,30 – ≤ 5,00 | 640 | 580 | 15,0 |
| | > 5,00 – ≤ 10,00 | 640 | 580 | 10,0 |
| | > 10,00 – ≤ 13,00 | 590 | 540 | 10,0 |
| | > 13,00 – ≤ 25,00 | 500 | 480 | 2,0 |
| | > 25,00 – 50,00 | 500 | 480 | 1,0 |

a) The density cannot be determined with sufficient accuracy for small material thickness below 1 mm. Due to the high degree of deformation during production, it is assumed that the theoretical density (above given value) is achieved.

b) The actual value quoted in certificates corresponds to the mean-value of a representative control sample.

c) Samples are taken crosswise to the last rolling direction.

| | | |
|------------------------------------|-------------------|----------------------------|
| Erichsen cupping values | Thickness [mm] | Cupping value min. [mm] |
| | 0,20 – ≤ 0,30 | 4,5 |
| | >0,30 – ≤ 0,40 | 5,5 |
| | >0,40 – ≤ 0,50 | 6,0 |
| | >0,50 – ≤ 0,60 | 6,5 |
| | >0,60 – ≤ 0,80 | 7,0 |
| | >0,80 – ≤ 1,00 | 8,0 |
| | >1,00 – ≤ 1,50 | 8,3 |
| | >1,50 – 2,00 | 8,5 |

Remarks: All Mo-sheets are delivered in stress relieved condition.

2.2 Surface condition

| | | |
|---------------------------|---|-----------------|
| Appearance: | <p>The material will be of uniform quality, free from foreign matter, splits and fractures. Bed sheets (not trimmed) may have small edge cracks.</p> <p>Surface defects are assessed in the frame of visual inspection.</p> <p>Local surface defects can be removed by grinding within the specified thickness tolerance.</p> | |
| Surface condition: | Cold rolled, bright (thickness ≤ 1 mm, width ≤ 800 mm): | Ra ≤ 0,20 μm *) |
| | Cold rolled, pickled: | Ra ≤ 1,00 μm *) |
| | Cold rolled, ground: **) | Ra ≤ 0,60 μm *) |
| | Hot rolled, pickled: | - |
| Luminosity factor: | Gloss level min. 230 (bright sheet surface ***) | |
| | (device type REFO 3-D / Dr. Lange) angle of incidence: 60° | |

*) across rolling direction

**) Upon request

***) Due to process, inherent reasons, the sheet sides may show different gloss.

3 Chemical composition

| Main and minor components | Plansee | | Standard | EU-Directive |
|---|---------------------|------------------|--------------------|--------------------|
| | Min. content [%] | | ASTM B386/361 | RoHS ^{a)} |
| Mo | 99.97 ^{b)} | | Rest | - |
| Impurities | Max. values [µg/g] | | Max. values [µg/g] | Max. values [µg/g] |
| | Typical | Guaranteed | | |
| Al | 1 | 10 | - | - |
| Cr | 3 | 20 | - | - |
| Cu | 2 | 20 | - | - |
| Fe | 5 | 20 | 100 | - |
| K | 6 | 20 | 50 | - |
| Ni | 1 | 10 | 100 | - |
| Si | 2 | 20 | - | - |
| W | 169 | 300 | - | - |
| C | 13 | 30 | 100 | - |
| H | - | 10 | - | - |
| N | 5 | 10 | 20 | - |
| O | 6 | 40 | 70 | - |
| Cd | 1 | 5 | - | 100 |
| Hg ^{c)} | - | 1 | - | 1000 |
| Pb | - | 5 | - | 1000 |
| Cr (VI) | | | - | 1000 |
| Organic impurities (e.g. PBB, PBDE, PFOS, PFOA) | - ^{**)} | - ^{**)} | - | 1000 |

a) EU-directives 2015/863/EU, 2011/65/EU and 2000/53/EC.

b) Metallic purity without W

c) Initial value

^{**)} The presence of Cr (VI) and organic impurities can definitely be excluded because of the production process (multiple heat treatments at temperatures above 1000 °C in H₂-atmosphere).

The chemical composition is checked by means of random sampling. The sampling inspection plan, analysis and evaluation methods are determined in the internal instruction PSE-020-WI-003. The application of the measured values for the chemical analysis is defined in PSE-680-WI-001.

Remarks: The specified physical and chemical characteristics are disclosed not regarding measurement accuracy.

4 Packaging, labelling, storage and certification

4.1 Packaging, labelling and storage

Standard individual packing:

Depending on their size, the sheets will be either packed individually or in parcels with liner between the different pieces.

Each package will be provided with a label with the following information:

| | |
|------------------------------|---|
| Producer's name: | Plansee |
| Plansee order number: | |
| Lot number: | |
| Material number: | |
| Material: | |
| Dimension: | e.g. thickness, width, length, diameter, etc. |
| Surface: | |
| Quantity: | Total quantity in kg or piece |
| Date: | |

The material must be kept in a dry place and protected from mechanical damage. It is best to keep the sheets in their original packing until used.

Special packing: (extra costs will be invoiced)

Special packing should be used if the material is stored under unusual conditions or aggressive atmosphere (e.g. sea air, ...).

4.2 Inspection documents

Following inspection documents will be supplied upon customer request according to EN 10 204:

Test report

Plansee confirms with this test report that the delivered product meets the specification and gives details of the material properties according to ongoing production surveillance, not directly related to the particular production batch.

Inspection certificate (extra costs will be invoiced)

An inspection officer from Plansee confirms with this inspection certificate that the delivered product meets the specification and gives test results related to the particular production batch.

5 Order instructions

Please quote following information when ordering:

- Product description
- Quality (the number of this specification must be mentioned)
- Dimension: thickness (width, length, diameter, etc.)
- Quantity (total quantity in kg or in piece)
- Required certificate and content in case of a 3.1 inspection certificate
- *For special packing:* Specification of packaging

For further information on our delivery possibilities, please look into our <http://www.plansee.com>

6 Referenced standards

The standards applied for the test methods are listed in the Plansee standard infobase and are made available upon request.

Mo-Sheet

Changes to last version

| Replacement for | Changes to last version |
|-----------------|---|
| 03 | ▪ Section 1.4 a : Tolerances for sheet cuts |