

(19)



(11)

**EP 4 818 343 A2**

(12)

## EUROPEAN PATENT APPLICATION

(43) Date of publication:

**07.10.2026 Bulletin 2026/41**

(51) International Patent Classification (IPC):

**C22C 5/04** (2006.01) **A44C 27/00** (2006.01)

(21) Application number: **26184895.6**

(52) Cooperative Patent Classification (CPC):

**C22C 5/04; A44C 27/003**

(22) Date of filing: **04.03.2024**

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB  
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL  
NO PL PT RO RS SE SI SK SM TR**

Designated Extension States:

**BA**

Designated Validation States:

**GE KH MA MD TN**

(30) Priority: **17.04.2023 CH 3912023**

**17.04.2023 IT 202300007407**

(62) Document number(s) of the earlier application(s) in  
accordance with Art. 76 EPC:

**24710514.1 / 4 698 686**

(71) Applicant: **Argor-Heraeus S.A.**

**6850 Mendrisio (CH)**

(72) Inventors:

- **Arnaboldi, Sergio**  
**23867 SUELLO (IT)**
- **Rossini, Marta**  
**6816 Bissone (CH)**
- **Nauer, Marco**  
**6834 MORBIO INFERIORE (CH)**
- **Galeotti, Federico**  
**22100 Como (IT)**

(74) Representative: **PGA S.p.A., Milano, Succursale  
di Lugano**

**Via Castagnola, 21c  
6900 Lugano (CH)**

Remarks:

This application was filed on 12.06.2026 as a  
divisional application to the application mentioned  
under INID code 62.

(54) **PLATINUM ALLOY**

(57) The present disclosure concerns a Platinum  
alloy for jewelry applications, comprising:

- Platinum, between 920 ‰ by weight and 980 ‰ by  
weight;

- Tin, between 5 ‰ by weight and 35 ‰ by weight;

- Ruthenium, between 8 ‰ by weight and 45 ‰ by weight  
or Copper, between 2 ‰ by weight and 45 ‰ by weight.

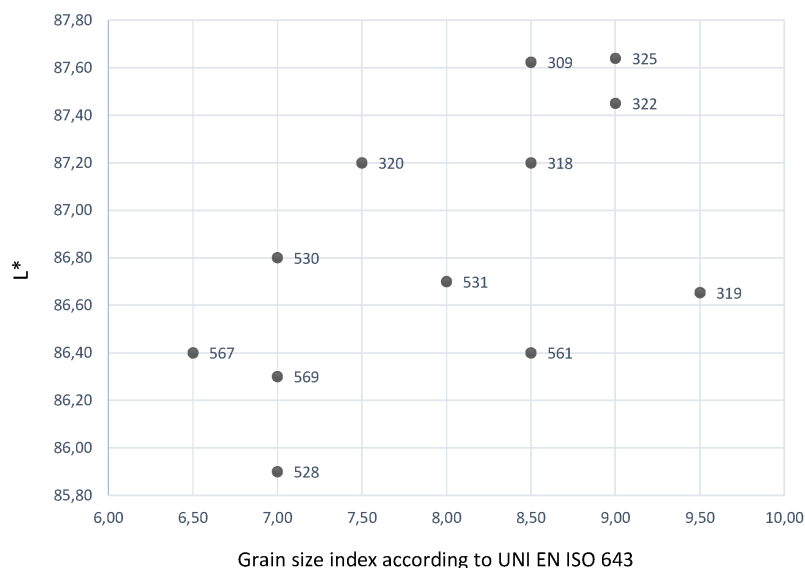


Fig.1

**Description****Technical field**

5 **[0001]** The present disclosure refers to the field of metallurgy, in particular to the field of Platinum alloys. In particular, the present disclosure concerns a Platinum alloy for jewelry applications.

**[0002]** The present disclosure also concerns a jewelry object realized with the Platinum alloy herein described.

**Background art**

10 **[0003]** Platinum alloys are metallic alloys that can be destined to jewelry applications. In particular, Platinum alloys can be advantageously used for realizing watch mechanisms, thanks to their mechanical and functional properties.

**[0004]** These mechanisms can be hidden by the caseback or, alternatively, they can be visible, completing the aesthetics of the object itself. In this particular case, the caseback typically shows a transparent element, e.g. made of sapphire crystal or plastic material, which allows the user - when the watch is not worn - to observe the inner mechanisms.

**[0005]** Platinum alloys can also be used for the realization of jewelry objects such as watch or bracelet components, destined for example to enter in direct contact with the human skin.

20 **[0006]** In the jewelry applications, the lightness or brilliance of the alloy plays an important role; the higher it is, the higher the aesthetic quality of the object is and consequently the alloy is more valued. In the CIELAB system, this property is defined by means of the coordinate  $L^*$ .

**[0007]** Platinum alloys for jewelry applications shall have optimal workability characteristics; in particular Platinum alloys must be able to be subjected to all the mechanical workings typically used for the production of jewels or watch parts. In particular, they shall not show defects such as cracks or fractures when subjected to deformation by plastic deformation (rolling, drawing, etc.) and/or mechanical workings by chip removal.

25 **[0008]** In the field of application considered, Platinum and Ruthenium alloys are known for the mechanical working; in particular it is known a binary alloy, which consists of Platinum 950 ‰ by weight and Ruthenium 50 ‰ by weight. These alloys, further than being characterized by a high melting temperature, higher than 1700 °C actually present workability limits, in particular during the chip removal steps. For example, the diamond polishing process, widely used for other precious alloy families - in particular for Gold alloys with different carats -, can be hardly used for the realization of components in binary alloys of Platinum and Ruthenium.

30 **[0009]** GB 546 897 A discloses improvements in the Platinum alloys for jewelry and dental applications and in particular discloses an alloy containing at least 82% of Platinum, 0.35 - 5% of Tin and the remaining part essentially consisting of one or more further metals of the Platinum group, each metal or metals being in an amount not less than 0,5%. Similarly, US 2 273 806 A discloses Platinum alloys comprising small quantities of Tin, for jewelry and dental applications.

35 **[0010]** The purpose of the present disclosure is to describe a Platinum alloy that allows to have better workability.

**Summary**

40 **[0011]** In order to overcome the above-described drawbacks and in order, in particular, to obtain an alloy with optimal workability property, the Applicant has conceived a Platinum alloy in accordance with the aspects herein described. These aspects can be combined with each other or with portions of the detailed description or of the claims.

**[0012]** In accordance with the present disclosure, it is described a Platinum alloy for jewelry applications, comprising:

- 45
- Platinum, between 920 ‰ by weight and 980 ‰ by weight;
  - Tin, between 5 ‰ by weight and 35 ‰ by weight;
  - Ruthenium, between 8 ‰ by weight and 45 ‰ by weight or Copper, between 2 ‰ by weight and 45 ‰ by weight.
- 50

**[0013]** According to a further non-limiting aspect, Tin is present between 10 ‰ by weight and 30 ‰ by weight, preferably between 12 ‰ by weight and 28 ‰ by weight.

**[0014]** According to a further non-limiting aspect, Copper is present between 4 ‰ by weight and 41 ‰ by weight, preferably between 8 ‰ by weight and 39 ‰ by weight, more preferably between 8 ‰ by weight and 34 ‰ by weight.

55 **[0015]** According to a further non-limiting aspect, Ruthenium is present between 10 ‰ by weight and 43 ‰ by weight, preferably between 15 ‰ by weight and 38 ‰ by weight, more preferably between 15 ‰ by weight and 35 ‰ by weight.

**[0016]** According to a further non-limiting aspect, Platinum is present between 930 ‰ by weight and 970 ‰ by weight, preferably between 940 ‰ by weight and 960 ‰ by weight.

**[0017]** According to a further non-limiting aspect, the alloy comprises:

- Tantalum, between 2 % by weight and 30 % by weight, preferably between 4 % by weight and 25 % by weight, more preferably between 8 % by weight and 20 % by weight, and/or
- Niobium, between 2 % by weight and 20 % by weight, preferably between 4 % by weight and 15 % by weight, more preferably between 5 % by weight and 10 % by weight.

**[0018]** According to a further non-limiting aspect, the sum by weight of Platinum, Tin, Ruthenium, Tantalum and/or Niobium, or the sum by weight of Platinum, Tin, Copper, Tantalum and/or Niobium is such to determine the achievement of 1000 % by weight of the alloy.

**[0019]** According to a further non-limiting aspect, the sum by weight of Platinum, Tin and Ruthenium is such to determine the achievement of 1000 % by weight of the alloy.

**[0020]** According to a further non-limiting aspect, the sum by weight of Platinum, Tin and Copper is such to determine the achievement of 1000 % by weight of the alloy.

**[0021]** According to a further non-limiting aspect, the alloy comprises:

- Chromium, between 2 % by weight and 18 % by weight, preferably between 5 % by weight and 15 % by weight; and/or
- Molybdenum, between 2 % by weight and 18 % by weight, preferably between 5 % by weight and 15 % by weight.

**[0022]** According to a further non-limiting aspect, the sum by weight of Platinum, Tin, Ruthenium, Chromium and/or Molybdenum, or the sum by weight of Platinum, Tin, Copper, Chromium and/or Molybdenum is such to determine the achievement of 1000 % by weight of the alloy.

**[0023]** According to a further non-limiting aspect, the alloy comprises:

- Gallium, between 5 % by weight and 23 % by weight, preferably between 8 % by weight and 20 % by weight, more preferably between 10 % by weight and 18 % by weight; or
- Gold, between 2 % by weight and 14 % by weight, preferably between 4 % by weight and 12 % by weight, more preferably between 6 % by weight and 8 % by weight; or
- Palladium, between 2 % by weight and 18 % by weight, preferably between 4 % by weight and 16 % by weight, more preferably between 6 % by weight and 14 % by weight.

**[0024]** According to a further non-limiting aspect, the sum by weight of Platinum, Tin, Copper, Gallium or Gold or Palladium is such to determine the achievement of 1000 % by weight of the alloy.

**[0025]** According to a further non-limiting aspect, the sum by weight of Platinum, Tin, Ruthenium, or Platinum Tin, Copper reached 970 % by weight of the alloy, preferably 975 % by weight of the alloy and more preferably 980 % by weight of the alloy.

**[0026]** According to a further non-limiting aspect, the Platinum alloy comprises at least one among Iridium, Rhenium, Vanadium, Indium, Hafnium, in amount overall not exceeding 30 % by weight, preferably not exceeding 25 % by weight and more preferably not exceeding 20 % by weight.

**[0027]** According to a further non-limiting aspect, the alloy herein described is characterized in that it is ternary or quaternary.

**[0028]** According to a further non-limiting aspect, the alloy herein described is characterized in that it has a color that in the CIELAB 1976 color space, and in accordance with the conditions of color measurement according to CIE D65, presents a coordinate L\* at least equal to 85.

**[0029]** According to a further non-limiting aspect, the alloy herein described is characterized in that it has a hardness at least equal to 150 Vickers points, optionally wherein when comprising Copper, said Platinum alloy is characterized in that it has a hardness at least equal to 155 Vickers points or wherein when comprising Ruthenium, said Platinum alloy is characterized in that it has a hardness at least equal to 160 on the Vickers scale, preferably at least equal to 170 on the Vickers scale.

**[0030]** According to a further non-limiting aspect, the alloy consists of Platinum between 930 % by weight and 970 % by weight, preferably between 940 % by weight and 960 % by weight, and Ruthenium, between 18 % by weight and 35 % by weight, preferably between 22 % by weight and 34 % by weight.

**[0031]** In accordance with the present disclosure it is also described a Platinum alloy consisting of:

- Platinum, between 920 ‰ by weight and 980 ‰ by weight, preferably between 930 ‰ by weight and 970 ‰ by weight, more preferably between 940 ‰ by weight and 960 ‰ by weight;
- Tin, between 5 ‰ by weight and 35 ‰ by weight, preferably between 10 ‰ by weight and 30 ‰ by weight, more preferably between 12 ‰ by weight and 28 ‰ by weight;
- alternatively:
  - Ruthenium, between 8 ‰ by weight and 45 ‰ by weight,
  - Copper, between 2 ‰ by weight and 45 ‰ by weight,
- at least one between:
  - Tantalum, between 2 ‰ by weight and 30 ‰ by weight, preferably between 4 ‰ by weight and 25 ‰ by weight, more preferably between 8 ‰ by weight and 20 ‰ by weight, and/or
  - Niobium, between 2 ‰ by weight and 20 ‰ by weight, preferably between 4 ‰ by weight and 15 ‰ by weight, more preferably between 5 ‰ by weight and 10 ‰ by weight,
- or, alternatively to Tantalum and/or Niobium, at least one between:
  - Chromium, between 2 ‰ by weight and 18 ‰ by weight, preferably between 5 ‰ by weight and 15 ‰ by weight; and/or
  - Molybdenum, between 2 ‰ by weight and 18 ‰ by weight, preferably between 5 ‰ by weight and 15 ‰ by weight,
- or, alternatively to Tantalum and/or Niobium and/or Chromium and/or Molybdenum, at least one between:
  - Gallium, between 5 ‰ by weight and 23 ‰ by weight, preferably between 8 ‰ by weight and 20 ‰ by weight, more preferably between 10 ‰ by weight and 18 ‰ by weight; or
  - Gold, between 2 ‰ by weight and 14 ‰ by weight, preferably between 4 ‰ by weight and 12 ‰ by weight, more preferably between 6 ‰ by weight and 8 ‰ by weight; or
  - Palladium, between 2 ‰ by weight and 18 ‰ by weight, preferably between 4 ‰ by weight and 16 ‰ by weight, more preferably between 6 ‰ by weight and 14 ‰ by weight.

**[0032]** In accordance with the present disclosure, it is described a jewelry object comprising a Platinum alloy in accordance with one or more of the present aspects.

**[0033]** According to a further non-limiting aspect, the jewelry object comprises a jewel or a watch or a watch bracelet or a movement or part of a mechanical watch movement.

**[0034]** According to a further non-limiting aspect, the watch bracelet is configured to be worn on the wrist and/or the movement or part of a mechanical watch movement, is configured to be installed in a wristwatch.

## **Figures**

**[0035]** Some embodiments of the Platinum alloy object of the present disclosure will now be described with reference to the attached figure, a short description thereof is given below.

**[0036]** Figure 1 shows a Cartesian diagram wherein on the abscissa it is present a datum related to a grain quality of the Platinum alloy; on the ordinate it is present a datum related to the brightness of the alloy, expressed as coordinate L\* referred to CIELAB 1976.

## **Detailed description**

**[0037]** The present disclosure describes a Platinum alloy for jewelry applications with high workability, in particular during chip removal and/or diamond polishing operations.

**[0038]** The Applicant has verified that the workability of the Platinum alloys is associated to the characteristics of the microstructure, and has carried out various studies on the grain refining elements which, when introduced in an alloy, have

the task of improving the workability characteristics of the alloy.

**[0039]** The Applicant has carried out various studies of specific compositions wherein in general Platinum is contained in the amount between 920 % by weight and 980 % by weight. Due to the high amount of Platinum, and considered the expensive cost of Platinum, it is clear that the main application of the Platinum alloy herein described is the one of the high jewelry/watchmaking. This does not exclude that there can be other applications of the Platinum alloy herein described.

The jewelry/watchmaking application shall not be intended for this reason in a limiting way.

**[0040]** Platinum alloys which are object of the present disclosure have been in-depth studied by the Applicant, and in particular have been subjected to an optical microscopic examination showing a microstructure characterized by a very fine grain, and show particularly high reflectance.

**[0041]** The Applicant focused in particular on the quality of the Platinum alloy, in terms of the average crystalline grain size and, secondarily, in terms of the homogeneity of the crystalline grain. The Applicant has also noted that the known alloys of Platinum and Ruthenium show significantly high melting temperatures. In fact, the melting temperatures of Platinum alloys and Ruthenium can be such that the melting crucible can partially crack, polluting the melted alloy with elements other than those of the intended composition.

**[0042]** For this reason, the Applicant has conceived a Platinum alloy which comprises Tin, between 5 % by weight and 35 % by weight. The inclusion of Tin in the Platinum alloy allowed to reduce the melting temperature of the alloy, with consequent reduction of the inclusion of pollutants and consequent greater flexibility in the selection of melting crucibles. The inclusion of Tin, has noted the Applicant, contributes to improve the workability of the alloy. The Applicant has also noted that the improvement of the workability of the alloy may also be given by the presence of Niobium in addition to Tin, or in partial replacement thereof.

**[0043]** In order to ensure suitable mechanical properties for jewelry processing, the Applicant has mainly focused on two families of Platinum - Tin alloys, in which, in addition to the above-mentioned Platinum and Tin, there are also Ruthenium or Copper.

**[0044]** The Applicant has noted that the Copper, generally, contributes to lower the melting temperature with respect to the Ruthenium. For this reason, the specific formulations which are characterized by the presence of Copper instead of Ruthenium, still showing an improved mechanical workability with respect to the Platinum alloys of known type, are less subjected to the introduction of pollutants released by the melting crucible.

**[0045]** Platinum alloys in accordance with the present disclosure have also been studied in terms of performance not only with variations of their chemical composition, but also as a function of diversified production processes.

**[0046]** The following table shows some specific compositions for the Platinum alloy studied by the Applicant.

Table 1

| Alloy      | Pt‰ | Ru‰ | Cu‰ | Ta‰ | Sn‰ | Nb‰ | Cr‰ | Mo‰ | Ga‰ | Pd‰ |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| <b>309</b> | 952 | 28  |     |     | 20  |     |     |     |     |     |
| <b>318</b> | 952 | 18  |     |     | 20  | 10  |     |     |     |     |
| <b>319</b> | 952 | 18  |     | 10  | 20  |     |     |     |     |     |
| <b>320</b> | 952 | 33  |     |     | 15  |     |     |     |     |     |
| <b>322</b> | 952 | 23  |     | 10  | 15  |     |     |     |     |     |
| <b>325</b> | 952 | 28  |     |     | 15  | 5   |     |     |     |     |
| <b>326</b> | 952 | 23  |     |     | 15  |     | 10  |     |     |     |
| <b>327</b> | 952 | 23  |     |     | 15  |     |     | 10  |     |     |
| <b>528</b> | 952 |     | 20  |     | 14  |     |     |     | 14  |     |
| <b>530</b> | 952 |     | 30  |     | 18  |     |     |     |     |     |
| <b>531</b> | 952 |     | 30  | 8   | 10  |     |     |     |     |     |
| <b>561</b> | 953 |     | 29  |     | 10  | 8   |     |     |     |     |
| <b>567</b> | 953 |     | 12  |     | 25  |     |     |     |     | 10  |
| <b>569</b> | 953 |     | 14  |     | 25  |     |     |     |     |     |

**[0047]** The compositions indicated in table 1 are specific compositions that the Applicant has obtained starting from a research carried out on a general family of Platinum alloys for jewelry applications, comprising:

- Platinum, between 920 ‰ by weight and 980 ‰ by weight;
- Tin, between 5 ‰ by weight and 35 ‰ by weight;
- 5 - Ruthenium, between 8 ‰ by weight and 45 ‰ by weight, or Copper, between 2 ‰ by weight and 45 ‰ by weight.

**[0048]** Platinum - Ruthenium alloys are traditionally used for jewelry applications, whereas Platinum - Copper alloys comprise compositions in which Copper is present as an alternative to Ruthenium, and represent more economical productive solutions due to the lower cost of Copper with respect to Ruthenium.

10 **[0049]** Copper and Ruthenium contribute to provide to the Platinum alloys a sufficient hardness and workability for the jewelry applications.

**[0050]** From the previous general family, the Applicant has focused the studies on a first general sub-family, wherein Tin is present between 10 ‰ by weight and 30 ‰ by weight, preferably between 12 ‰ by weight and 28 ‰ by weight.

15 **[0051]** Selecting from the general family the alloys that present Copper instead of Ruthenium, the Applicant has focused itself in particular on a second sub-family of alloys wherein Copper is present between 4 ‰ by weight and 41 ‰ by weight, preferably between 8 ‰ by weight and 39 ‰ by weight, more preferably between 8 ‰ by weight and 34 ‰ by weight.

**[0052]** Alternatively, selecting from the general family the alloys that present Ruthenium instead of Copper, the Applicant has focused itself in particular on a third sub-family of alloys wherein Ruthenium is present between 10 ‰ by weight and 43 ‰ by weight, preferably between 15 ‰ by weight and 38 ‰ by weight, more preferably between 15 ‰ by weight and 35 ‰ by weight.

20 **[0053]** Further in-depth studies have been carried out on alloys wherein Platinum is present between 930 ‰ by weight and 970 ‰ by weight, preferably between 940 ‰ by weight and 960 ‰ by weight. The quantities of Platinum herein introduced have been studied in particular both in relation to compositions in accordance with the first sub-family and to compositions in accordance with the second and third sub-family.

25 **[0054]** The Applicant has conceived some embodiments of the alloy according to the present disclosure which present a non-negligible quantity of Tantalum. From an analysis carried out by the Applicant, the presence of Tantalum, in some cases in partial replacement of Ruthenium, has determined a further reduction of the grain size of the alloy, and the so-obtained alloys result characterized by a lightness greater with respect to compositions of Platinum alloy wherein Tantalum is absent. The Applicant has also conceived a family of Platinum alloys wherein it is present Niobium and/or Chromium.

30 **[0055]** In particular, the Applicant has focused Platinum alloys wherein it is present:

- Tantalum, between 2 ‰ by weight and 30 ‰ by weight, preferably between 4 ‰ by weight and 25 ‰ by weight, more preferably between 8 ‰ by weight and 20 ‰ by weight, and/or
- 35 - Niobium, between 2 ‰ by weight and 20 ‰ by weight, preferably between 4 ‰ by weight and 15 ‰ by weight, more preferably between 5 ‰ by weight and 10 ‰ by weight.

**[0056]** Some alloys of the sub-family including Tantalum and/or Niobium in the quantities indicated in the previous paragraph are quaternary alloys, wherein the sum by weight of Platinum, Tin, Ruthenium, Tantalum and/or Niobium, or - for the alloys containing Copper instead of Ruthenium - the sum by weight of Platinum, Tin, Copper, Tantalum and/or Niobium is such to determine the achievement of 1000 ‰ by weight of the alloy.

40 **[0057]** These latter families are the ones that brought to the realization of the final compositions according to table 1 for example with codes 318, 319, 322, 531, 561.

**[0058]** As previously mentioned, the Applicant has studied other families of Platinum alloys wherein it is present:

- 45 - Chromium, between 2 ‰ by weight and 18 ‰ by weight, preferably between 5 ‰ by weight and 15 ‰ by weight; and/or
- Molybdenum, between 2 ‰ by weight and 18 ‰ by weight, preferably between 5 ‰ by weight and 15 ‰ by weight.

50 **[0059]** Some alloys of the sub-family including Chromium and/or Molybdenum in the quantities indicated in the previous paragraph are quaternary alloys, i.e. wherein the sum by weight of Platinum, Tin, Ruthenium, Chromium and/or Molybdenum, or - for the alloys containing Copper instead of Ruthenium - the sum by weight of Platinum, Tin, Copper, Chromium and/or Molybdenum is such to determine the achievement of 1000 ‰ by weight of the alloy.

55 **[0060]** These latter families are the ones that brought to the realization of the final compositions according to table 1 for example with codes 326 and 327.

**[0061]** Starting from the previously mentioned general family of compositions, and including the limits of the first, second and third sub-family, and with further analyses carried out on compositions wherein Platinum is present between 930 ‰ by weight and 970 ‰ by weight, preferably between 940 ‰ by weight and 960 ‰ by weight, the Applicant has conceived a

plurality of families of Platinum alloys which, further than Platinum, Copper or Ruthenium in the above-described quantities comprises:

- Gallium, between 5 % by weight and 23 % by weight, preferably between 8 % by weight and 20 % by weight, more preferably between 10 % by weight and 18 % by weight; or
- Gold, between 2 % by weight and 14 % by weight, preferably between 4 % by weight and 12 % by weight, more preferably between 6 % by weight and 8 % by weight; or
- Palladium, between 2 % by weight and 18 % by weight, preferably between 4 % by weight and 16 % by weight, more preferably between 6 % by weight and 14 % by weight.

**[0062]** The Applicant has focused in particular on the quaternary Platinum alloys, i.e. the ones in which the sum by weight of Platinum, Tin, Copper, and one among Gallium or Gold or Palladium is such to determine the achievement of 1000 % by weight of the alloy.

**[0063]** Further families of Platinum alloys studied by the Applicant are the ones in which the sum by weight of Platinum, Tin, Ruthenium, or Platinum, Tin, Copper reaches 970 % by weight of the alloy, preferably 975 % by weight of the alloy and more preferably 980 % by weight of the alloy; this family of Platinum alloys is characterized by the presence of at least one between Iridium, Rhodium, Vanadium, Indium, Hafnium, in amount overall not exceeding 30 % by weight, preferably not exceeding 25 % by weight and more preferably not exceeding 20 % by weight.

**[0064]** A particular sub-family of Platinum alloys carefully studied by the Applicant is the family of ternary alloys that from the general family, and with the limits of at least one between the first sub-family and the third sub-family of Platinum alloys, and with particular reference to the contents of Platinum in an amount between 930 % by weight and 970 % by weight, preferably between 940 % by weight and 960 % by weight, present only Ruthenium, between 18 % by weight and 35 % by weight, preferably between 22 % by weight and 34 % by weight.

**[0065]** In light of the above-mentioned considerations, it is therefore clear that the present disclosure shows a Platinum alloy consisting in:

- Platinum, between 920 % by weight and 980 % by weight, preferably between 930 % by weight and 970 % by weight, more preferably between 940 % by weight and 960 % by weight;
- Tin, between 5 % by weight and 35 % by weight, preferably between 10 % by weight and 30 % by weight, more preferably between 12 % by weight and 28 % by weight;
- alternatively:
  - Ruthenium, between 8 % by weight and 45 % by weight,
  - Copper, between 2 % by weight and 45 % by weight,
- at least one between:
  - Tantalum, between 2 % by weight and 30 % by weight, preferably between 4 % by weight and 25 % by weight, more preferably between 8 % by weight and 20 % by weight, and/or
  - Niobium, between 2 % by weight and 20 % by weight, preferably between 4 % by weight and 15 % by weight, more preferably between 5 % by weight and 10 % by weight,
- or, alternatively to Tantalum and/or Niobium, at least one between:
  - Chromium, between 2 % by weight and 18 % by weight, preferably between 5 % by weight and 15 % by weight; and/or
  - Molybdenum, between 2 % by weight and 18 % by weight, preferably between 5 % by weight and 15 % by weight,
- or, alternatively to Tantalum and/or Niobium and/or Chromium and/or Molybdenum, at least one among:
  - Gallium, between 5 % by weight and 23 % by weight, preferably between 8 % by weight and 20 % by weight, more

preferably between 10 % by weight and 18 % by weight; or

- Gold, between 2 % by weight and 14 % by weight, preferably between 4 % by weight and 12 % by weight, more preferably between 6 % by weight and 8 % by weight; or
- Palladium, between 2 % by weight and 18 % by weight, preferably between 4 % by weight and 16 % by weight, more preferably between 6 % by weight and 14 % by weight.

**[0066]** The compositions of table 1 have been obtained as specific embodiments of particular subfamilies of Platinum alloys based on the above-described studies and obtained as preferred compositions for the following subfamilies.

**[0067]** The composition 309 is part of a sub-family of a Platinum alloy which consists of Platinum, between 947 % by weight and 957 % by weight, Tin, between 15 % by weight and 25 % by weight, Ruthenium, between 23 % by weight and 33 % by weight.

**[0068]** The composition 318 is part of a sub-family of a Platinum alloy which consists of Platinum, between 947 % by weight and 957 % by weight, Tin, between 15 % by weight and 25 % by weight, Ruthenium between 13 % by weight and 23 % by weight, Niobium, between 5 % by weight and 15 % by weight.

**[0069]** The composition 319 is part of a sub-family of a Platinum alloy which consists of Platinum, between 947 % by weight and 957 % by weight, Tin between 15 % by weight and 25 % by weight, Ruthenium between 13 % by weight and 23 % by weight, Tantalum, between 5 % by weight and 15 % by weight.

**[0070]** The Applicant notes in particular that the compositions 309, 318 and 319 can be enclosed in a specific sub-family of Platinum alloys which consists of:

- Platinum, between 942 % by weight and 963 % by weight, preferably between 947 % by weight and 957 % by weight,
- Tin, between 10 % by weight and 30 % by weight, preferably between 15 % by weight and 25 % by weight,
- Ruthenium, between 18 % by weight (or 21 % by weight) and 35 % by weight, preferably between 23 % by weight and 33 % by weight,
- optionally at least one between, preferably one between, Niobium, between 2 % by weight and 17 % by weight, preferably between 5 % by weight and 15 % by weight, and/or Tantalum between 2 % by weight and 17 % by weight, preferably between 5 % by weight and 15 % by weight,

wherein, i.e., the sum of Platinum, Tin and Ruthenium and, optionally, Niobium and/or Tantalum, reaches 1000 % by weight. This alloy is therefore a ternary or quaternary or, optionally, quinary alloy.

**[0071]** The composition 320 is part of a sub-family of a Platinum alloy which consists of Platinum, between 947 % by weight and 957 % by weight, Tin, between 10 % by weight and 20 % by weight, Ruthenium between 26 % by weight and 40 % by weight.

**[0072]** The composition 322 is part of a sub-family of a Platinum alloy which consists of Platinum, between 947 % by weight and 957 % by weight, Tin, between 10 % by weight and 20 % by weight, Ruthenium, between 18 % by weight and 28 % by weight, Tantalum, between 5 % by weight and 15 % by weight.

**[0073]** The composition 325 is part of a sub-family of a Platinum alloy which consists of Platinum, between 947 % by weight and 957 % by weight, Tin, between 10 % by weight and 20 % by weight, Ruthenium, between 23 % by weight and 33 % by weight, Niobium, between 2 % by weight and 10 % by weight.

**[0074]** The composition 326 is part of a sub-family of a Platinum alloy which consists of Platinum, between 947 % by weight and 957 % by weight, Tin, between 10 % by weight and 20 % by weight, Ruthenium, between 18 % by weight and 28 % by weight, Chromium, between 5 % by weight and 15 % by weight.

**[0075]** The composition 327 is part of a sub-family of a Platinum alloy which consists of Platinum, between 947 % by weight and 957 % by weight, Tin, between 10 % by weight and 20 % by weight, Ruthenium, between 18 % by weight and 28 % by weight, Molybdenum, between 5 % by weight and 15 % by weight.

**[0076]** The composition 528 is part of a sub-family of a Platinum alloy which consists of Platinum, between 947 % by weight and 957 % by weight, Tin, between 9 % by weight and 19 % by weight, Copper, between 15 % by weight and 25 % by weight, Gallium between 7 % by weight and 21 % by weight.

**[0077]** The composition 530 is part of a sub-family of a Platinum alloy which consists of Platinum, between 947 % by weight and 957 % by weight, Tin, between 13 % by weight and 23 % by weight, Copper, between 25 % by weight and 35 % by weight.

**[0078]** The composition 531 is part of a sub-family of a Platinum alloy which consists of Platinum, between 947 % by weight and 957 % by weight, Tin, between 5 % by weight and 15 % by weight, Copper, between 25 % by weight and 35 %

## EP 4 818 343 A2

by weight, Tantalum, between 2 % by weight and 13 % by weight.

**[0079]** The composition 561 is part of a sub-family of a Platinum alloy which consists of Platinum, between 948 % by weight and 958 % by weight, Tin, between 5 % by weight and 15 % by weight, Copper, between 24 % by weight and 34 % by weight, Niobium, between 2 % by weight and 13 % by weight.

**[0080]** The Applicant notes in particular that the compositions 531 and 561 can be enclosed in a specific sub-family of Platinum alloys which consists of:

- Platinum, between 942 % by weight and 963 % by weight, preferably between 947 % by weight and 957 % by weight or between 948 % by weight and 958 %,
- Tin, between 2 % by weight and 17 % by weight, preferably between 5 % by weight and 15 % by weight,
- Copper, between 21 % by weight and 39 % by weight, preferably between 25 % by weight and 35 % by weight or between 24 % by weight and 34 % by weight,
- at least one between, preferably one between, Tantalum, 2 % by weight and 13 % by weight preferably between 3 % by weight and 12 % by weight, or Niobium, between 2 % by weight and 13 % by weight, preferably between 3 % by weight and 12 % by weight,

wherein the sum of Platinum, Tin, Copper and, optionally, Tantalum and/or Niobium, reaches 1000 % by weight.

**[0081]** The composition 567 is part of a sub-family of a Platinum alloy which consists of Platinum, between 948 % by weight and 958 % by weight, Tin, between 20 % by weight and 30 % by weight, Copper, between 7 % by weight and 17 % by weight, Palladium, between 5 % by weight and 15 % by weight.

**[0082]** The composition 569 is part of a sub-family of a Platinum alloy which consists of Platinum, between 948 % by weight and 958 % by weight, Tin, between 20 % by weight and 30 % by weight, Copper, between 9 % by weight and 19 % by weight.

**[0083]** The table 2 below shows some physical characteristics of the specific Platinum alloy compositions described in table 1. The two tables are divided for ease of graphical representation.

**[0084]** In the table below there is a column showing the qualitative characteristic of the grain, in particular downstream of an annealing step of the alloy. This qualitative characteristic is defined by an index in accordance with what is described in UNI EN ISO 643, which provides the use of a standardized grid and the use of optical or electronic microscopy to assess grain size and/or homogeneity.

**[0085]** The annealing of the Platinum alloy herein described is carried out at a lower temperature with respect to the melting one, and is subsequently followed by a step of slow and/or controlled cooling.

**[0086]** The higher the value indicated in the above-mentioned column, the smaller the average grain size, and the higher the quality of the Platinum alloy. A further column shows the coordinate L\*, which on the CIELAB colour scale identifies the lightness of the alloy. A higher lightness value corresponds to a better quality of the alloy.

Table 2

| Alloy | Annealed state hardness | Grain size index according to UNI EN ISO 643 after annealing (G) | L*    |
|-------|-------------------------|------------------------------------------------------------------|-------|
| 309   | 176                     | 8/9                                                              | 87,62 |
| 318   | 186                     | 8/9                                                              | 87,20 |
| 319   | 206                     | 9/10                                                             | 86,65 |
| 320   | 190                     | 7/8                                                              | 87,20 |
| 322   | 190                     | 9                                                                | 87,45 |
| 325   | 194                     | 9                                                                | 87,64 |
| 326   | 217                     | 9                                                                | 87,41 |
| 327   | 196                     | 9                                                                | 87,18 |
| 528   | 184                     | 7                                                                | 85,90 |
| 530   | 157                     | 7                                                                | 86,80 |
| 531   | 190                     | 8                                                                | 86,70 |
| 561   | 172                     | 8/9                                                              | 86,40 |

(continued)

| Alloy | Annealed state hardness | Grain size index according to UNI EN ISO 643 after annealing (G) | L*    |
|-------|-------------------------|------------------------------------------------------------------|-------|
| 567   | 178                     | 6/7                                                              | 86,40 |
| 569   | 171                     | 7                                                                | 86,30 |

**[0087]** In table 2, hardness values are shown in accordance with the Vickers scale. All the specific compositions described in table 2 show better workability characteristics with respect to known alloys, both before and after remelting.

**[0088]** All the specific compositions described in table 2 show homogeneous grain.

**[0089]** The brightness of the alloy, which is physically expressed as reflectance, is partially related to grain size. The larger the grain size, the more uneven the surface of an object realized with the alloy. For this reason, the reflectance decreases with increasing grain size and, on the contrary, increases with decreasing grain size. However, it can be argued that to a higher coordinate L\* does not necessarily correspond an equivalent grain with a smaller average size. In fact, the coordinate L\* can be influenced by other factors.

**[0090]** In particular, it is noted that Platinum alloys in which is present Ruthenium (compositions 309, 318, 319, 320, 322, 325, 326, 327) show in average a greater lightness with respect to Platinum alloys in which it is present Copper (compositions 528, 530, 531, 561, 567, 569). However, as already previously indicated, Platinum alloys conceived in this way show a higher cost with respect to those in which Ruthenium is replaced by Copper.

**[0091]** The Applicant notes, by way of comparison, that under the same measurement conditions of the compositions of table 2, pure Platinum shows a coordinate L\* = 87.5. Compositions 309, 325 therefore show an even greater lightness than pure Platinum.

**[0092]** In table 2, from the column related to the grain size index, it is noted that the use of Ruthenium as an alternative to Copper allows to obtain on average better and, above all, uniform grains. Consequently, the surface finishing of the Platinum - Tin - Ruthenium compositions in the quantities described in the present disclosure can be on average higher with respect to the surface finishing of the Platinum - Tin - Copper compositions in the quantities described in the present disclosure.

**[0093]** It is also noted that the presence of Tantalum can determine a perceptible improvement of the grain. Comparing in fact the composition 320 and the composition 322, where the second one has 10% less Ruthenium, replaced with an equivalent amount by weight of Tantalum, it is noted that the composition 322 shows a grain size index of 9 versus 7/8 of the composition 320.

**[0094]** In terms of hardness in the annealed state, the Platinum-Tin alloys comprising Ruthenium are on average harder with respect to the Platinum-Tin alloys comprising Copper as an alternative to Ruthenium; the exception is represented by the composition 531, which - due to the presence of Tantalum - shows instead a hardness comparable to the hardness of the Platinum - Tin - Ruthenium alloys.

**[0095]** From table 2, the graph of figure 1 has been extracted, which shows on the abscissa the grain quality (index according to UNI EN ISO 643) as per the penultimate column of table 2 and on the ordinate the coordinate L\* as per the last column of table 2. From the graph of figure 1, it emerges that the overall best compositions in terms of grain quality/lightness ratio can firstly be considered the compositions 325, 322, 309, 318, 319 and subsequently, in a narrower group, the compositions 325 and 322.

**[0096]** Colors of Platinum alloys are univocally measured in the CIELAB 1976 color space, which defines a color on the basis of a first parameter L\*, a second parameter a\* and a third parameter b\*, wherein the first parameter L\* identifies the lightness and assumes values between 0 (black) and 100 (white) while the second parameter a\* and the third parameter b\* represent chromaticity parameters. In particular, in the CIELAB 1976 color range, the achromatic gray scale is identified by the points wherein a\*=b\*=0; positive values for the second parameter a\* indicate a color tending more towards red the more the value of the second parameter is high; negative values for the second parameter a\* indicate a color tending more towards green the more the value of the second parameter a\* is high in absolute value, even if negative; positive values for the third parameter b\* indicate a color tending more towards yellow the more the value of the third parameter is high; negative values for the third parameter b\* indicate a color tending more towards blue the more the value of the third parameter b\* is high in absolute value, even if negative. Furthermore, it is possible to transform the second parameter a\* and the third parameter b\* into polar parameters defined as follows:

$$C_{ab}^* = \sqrt{(a^*)^2 + (b^*)^2}$$

$$h_{ab*} = \tan^{-1} \left( \frac{b^*}{a^*} \right)$$

**[0097]** The  $C_{ab}^*$  parameter is defined as "chroma"; the higher is the value of the  $C_{ab}^*$  parameter, the higher will be the saturation of the color; the lower is the value of the  $C_{ab}^*$  parameter, the lower will be the color saturation, which will tend towards the gray scale.

**[0098]** From table 2, and in particular from studies carried out by the Applicant on the various families of Platinum alloys herein described, it has been noted that particular interest is given to those specific compositions which, falling within the ranges of the previously described elements, assume a colour that in the CIELAB 1976 colour space, and in accordance with the colour measurement conditions according to CIE D65, shows a coordinate  $L^*$  at least equal to 85. Preferably, alloys of particular interest show a coordinate  $L^*$  at least equal to 85,5.

**[0099]** Moreover, particular interest can be observed from the compositions of table 2 for those alloys characterized by a hardness at least equal to 150 on Vickers scale.

**[0100]** In particular when comprising Copper, Platinum alloy object of the present disclosure is characterized in that it has a hardness at least equal to 155 on Vickers scale.

**[0101]** When, instead, the alloy comprises Ruthenium, said Platinum alloy is characterized in that it has a hardness at least equal to 160 on Vickers scale, preferably at least equal to 170 on Vickers scale.

**[0102]** In an embodiment, the melting process of the herein described Platinum alloy is a discontinuous melting process. The discontinuous melting process is a process wherein the mixture is melted and cast into a mould or ingot, realized in graphite. In this case, the above indicated elements are melted and cast in a controlled atmosphere.

**[0103]** More in particular the melting operations are carried out only after having preferably conducted at least 3 cycles of conditioning of the atmosphere in the melting chamber. This conditioning first of all involves reaching a vacuum level down to pressures lower than  $1 \times 10^{-2}$  mbar and a subsequent partial saturation with Argon at 500mbar. During the melting, the Argon pressure is maintained at pressure levels between 500mbar and 800mbar. When it is reached the complete melting of the pure elements, a step of superheating of the mixture takes place, in which the mixture is heated up to a temperature between 1600 °C and 1850 °C in order to homogenize the chemical composition of the metal bath. During the step of superheating, the value of pressure in the melting chamber again reaches a vacuum level lower than  $1 \times 10^{-2}$  mbar, useful for eliminating part of the slag produced by the melting of pure elements.

**[0104]** At this point, in a step of casting, the melted material is poured into a mould or ingot.

**[0105]** Once solidified, the bars or castings are extracted from the bracket. When the alloy is solidified, Platinum alloy bars or castings are obtained from the graphite conduit and are subjected to a quick cooling by a step of water immersion, in order to reduce and possibly avoid phase variations. In other words, the bars or castings are subjected to a step of quick cooling, preferably but not limited to water, in order to avoid phase changes at the solid state.

**[0106]** Platinum alloys in accordance with the present disclosure can also be processed in a particularly effective manner to result with uniform surfaces, free from visible second phases or carbides. Therefore, Platinum alloys in accordance with the present disclosure can be favorably used for high jewelry applications, and in particular for realizing high jewelry objects.

**[0107]** Non-limiting examples of jewelry objects realized at least partially by means of the Platinum alloy herein described are: bracelets, watch bracelets, buckles, watch cases, watch hands, watch inner mechanisms, bracelet bezels, earrings, ornaments, rings, gemstone holders, ingots, in particular collector's ingots, collector's coins, necklaces, closing elements for necklaces, for earrings or for bracelets.

**[0108]** Platinum alloys in accordance with the present disclosure can be applicable for objects which enter in direct contact with the human skin, and are at a substantially null allergy risk.

**[0109]** Platinum alloys object of the present disclosure present particular lightness and optimal mechanical workability, being therefore particularly useful for being used in jewelry applications.

**[0110]** It is finally clear that to the object of the present disclosure can be applied additions, modifications or variants that are obvious to an expert in the art, without thereby departing from the scope provided by the attached claims.

## Claims

### 1. Platinum alloy for jewelry applications, comprising:

- Platinum, between 920 ‰ by weight and 980 ‰ by weight;
- Tin, between 5 ‰ by weight and 35 ‰ by weight;
- Ruthenium, between 8 ‰ by weight and 45 ‰ by weight or Copper, between 2 ‰ by weight and 45 ‰ by weight.

2. Platinum alloy according to claim 1, wherein Tin is present between 10 % by weight and 30 % by weight, preferably between 12 % by weight and 28 % by weight.
3. Platinum alloy according to claim 1 or 2, wherein Copper is present between 4 % by weight and 41 % by weight, preferably between 8 % by weight and 39 % by weight, more preferably between 8 % by weight and 34 % by weight.
4. Platinum alloy according to claim 1 or 2, wherein Ruthenium is present between 10 % by weight and 43 % by weight, preferably between 15 % by weight and 38 % by weight, more preferably between 15 % by weight and 35 % by weight.
5. Platinum alloy according to one or more of the preceding claims, wherein Platinum is present between 930 % by weight and 970 % by weight, preferably between 940 % by weight and 960 % by weight.

6. Platinum alloy according to one or more of the preceding claims, comprising:

- Tantalum, between 2 % by weight and 30 % by weight, preferably between 4 % by weight and 25 % by weight, more preferably between 8 % by weight and 20 % by weight, and/or
- Niobium, between 2 % by weight and 20 % by weight, preferably between 4 % by weight and 15 % by weight, more preferably between 5 % by weight and 10 % by weight;

wherein the sum by weight of Platinum, Tin, Ruthenium, Tantalum and/or Niobium, or the sum by weight of Platinum, Tin, Copper, Tantalum and/or Niobium is such to determine the achievement of 1000 % by weight of the alloy.

7. Platinum alloy according to one or more of the preceding claims, comprising:

- Chromium, between 2 % by weight and 18 % by weight, preferably between 5 % by weight and 15 % by weight; and/or
- Molybdenum, between 2 % by weight and 18 % by weight, preferably between 5 % by weight and 15 % by weight;

wherein the sum by weight of Platinum, Tin, Ruthenium, Chromium and/or Molybdenum, or the sum by weight of Platinum, Tin, Copper, Chromium and/or Molybdenum is such to determine the achievement of 1000 % by weight of the alloy.

8. Platinum alloy according to one or more of the preceding claims, comprising:

- Gallium, between 5 % by weight and 23 % by weight, preferably between 8 % by weight and 20 % by weight, more preferably between 10 % by weight and 18 % by weight; or
- Gold, between 2 % by weight and 14 % by weight, preferably between 4 % by weight and 12 % by weight, more preferably between 6 % by weight and 8 % by weight; or
- Palladium, between 2 % by weight and 18 % by weight, preferably between 4 % by weight and 16 % by weight, more preferably between 6 % by weight and 14 % by weight;

wherein the sum by weight of Platinum, Tin, Copper, Gallium or Gold or Palladium is such to determine the achievement of 1000 % by weight of the alloy.

9. Platinum alloy according to one or more of the claims from 1 to 5, wherein the sum by weight of Platinum, Tin, Ruthenium, or Platinum, Tin, Copper reaches 970 % by weight of the alloy, preferably 975 % by weight of the alloy and more preferably 980 % by weight of the alloy, the Platinum alloy comprising at least one among Iridium, Rhenium, Vanadium, Indium, Hafnium, in amount overall not exceeding 30 % by weight, preferably not exceeding 25 % by weight and more preferably not exceeding 20 % by weight.

10. Platinum alloy according to one or more of the preceding claims, **characterized in that** it is ternary or quaternary and/or **in that** it has a color that in the CIELAB 1976 color space, and in accordance with the conditions of color measurement according to CIE D65, presents a coordinate L\* at least equal to 85, and/or **characterized in that** it has a hardness at least equal to 150 Vickers points, optionally wherein when comprising Copper, said Platinum alloy is **characterized in that** it has a hardness at least equal to 155 Vickers points or wherein when comprising Ruthenium, said Platinum alloy is **characterized in that** it has a hardness at least equal to

160 Vickers points, preferably at least equal to 170 Vickers points.

**11.** Platinum alloy according to one or more of the preceding claims, consisting of:

- 5           - Platinum, between 920 % by weight and 980 % by weight, preferably between 930 % by weight and 970 % by weight, more preferably between 940 % by weight and 960 % by weight;  
           - Tin, between 5 % by weight and 35 % by weight, preferably between 10 % by weight and 30 % by weight, more preferably between 12 % by weight and 28 % by weight;  
           - alternatively:
- 10                 - Ruthenium, between 8 % by weight and 45 % by weight,  
                   - Copper, between 2 % by weight and 45 % by weight,
- at least one between:
- 15                 - Tantalum, between 2 % by weight and 30 % by weight, preferably between 4 % by weight and 25 % by weight, more preferably between 8 % by weight and 20 % by weight, and/or  
                   - Niobium, between 2 % by weight and 20 % by weight, preferably between 4 % by weight and 15 % by weight, more preferably between 5 % by weight and 10 % by weight,
- 20                 - or, alternatively to Tantalum and/or Niobium, at least one between:
- Chromium, between 2 % by weight and 18 % by weight, preferably between 5 % by weight and 15 % by weight; and/or
- 25                 - Molybdenum, between 2 % by weight and 18 % by weight, preferably between 5 % by weight and 15 % by weight,
- or, alternatively to Tantalum and/or Niobium and/or Chromium and/or Molybdenum, at least one between:
- 30                 - Gallium, between 5 % by weight and 23 % by weight, preferably between 8 % by weight and 20 % by weight, more preferably between 10 % by weight and 18 % by weight; or  
                   - Gold, between 2 % by weight and 14 % by weight, preferably between 4 % by weight and 12 % by weight, more preferably between 6 % by weight and 8 % by weight; or
- 35                 - Palladium, between 2 % by weight and 18 % by weight, preferably between 4 % by weight and 16 % by weight, more preferably between 6 % by weight and 14 % by weight.

**12.** Jewelry object comprising a Platinum alloy according to one or more of the preceding claims.

40

45

50

55

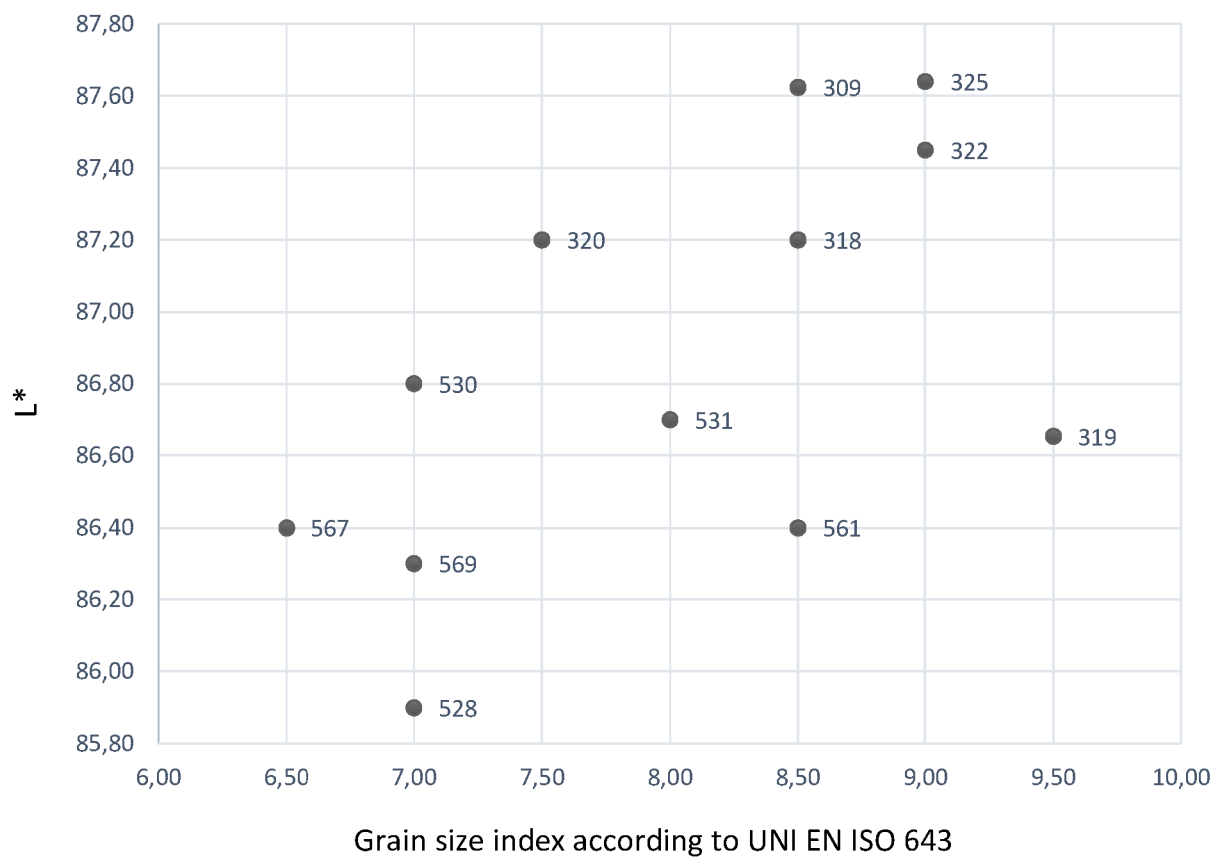


Fig.1

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- GB 546897 A [0009]
- US 2273806 A [0009]