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(54) **PLATINIUM BASED ALLOY, USE THEREOF**

(57) The invention relates to a platinum based alloy consisting of:

- 850 wt% or more of platinum,
- from 0.1 wt% to 100 wt% of a first alloying element which is at least one of manganese and vanadium,
- from 0.1 wt% to 100 wt% of a second alloying element which is at least one of palladium and chromium,
- wherein it necessarily contains at least a third alloying

element in an amount of more than 0 wt% but less than 99.9 wt%,

wherein the third alloying element is selected from the group consisting of iridium, copper, gold, iron, aluminum, tungsten, rhodium, germanium, yttrium, and mixtures thereof.

This alloy may be used to manufacture luxury goods.

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Description**FIELD OF THE INVENTION**

5 **[0001]** The invention relates to a platinum based alloy comprising platinum and at least three different alloying elements. Due to its properties such as hardness, porosity or grain size, this alloy may be used to manufacture luxury goods.

BACKGROUND OF THE INVENTION

10 **[0002]** Due to their properties, for instance their resistance to corrosion and oxidation, precious metals have been used in jewelry for ages. However, metals such as gold or platinum are usually alloyed with one or more elements in order to improve their hardness and their ductility.

[0003] Since gold is a soft metal, it is usually alloyed with copper, silver or palladium in order to increase its hardness. The presence of additional elements can also allow the formulation of colored gold. For instance, gold may be alloyed with nickel or palladium so as to afford white gold. Gold may be alloyed with copper so as to afford rose gold.

15 **[0004]** On the other hand, platinum may be alloyed with one or more of gallium, copper, cobalt, tungsten, iridium, rhodium, ruthenium... The introduction of specific elements may improve the castability and workability of platinum, as well as the quality of the final casted parts regarding mechanical properties, color, polished state, porosities...

[0005] Although countless platinum alloys have been developed over the last decades, there is still a need for new alloys having excellent castability and quality of the final casted items while affording hardness, porosity and grain size suitable for use in jewelry.

20 **[0006]** The present invention provides a platinum based alloy exhibiting these properties. It also affords an alternative to platinum alloys comprising gallium.

SUMMARY OF THE INVENTION

[0007] The present invention relates to a platinum based alloy that is easily castable and exhibits optimal properties and quality such as workability, hardness, porosity and grain size. Dues to its properties, this alloy is particularly appropriate for substituting the PtCuGa alloy commonly used in jewelry applications.

30 **[0008]** More specifically, the invention relates to a platinum based alloy consisting of:

- 850 wt% or more of platinum (Pt),
- from 0.1 wt% to 100 wt% of a first alloying element which is at least one of manganese (Mn) and vanadium (V),
- from 0.1 wt% to 100 wt% of a second alloying element which is at least one of palladium (Pd) and chromium (Cr),
- 35 - wherein the platinum based alloy necessarily contains at least a third alloying element in an amount of more than 0 wt% but less than 99.9 wt%,
wherein the third alloying element is selected from the group consisting of iridium (Ir), copper (Cu), gold (Au), iron (Fe), aluminum (Al), tungsten (W), rhodium (Rh), germanium (Ge), yttrium (Y), and mixtures thereof.

40 **[0009]** It is within the skills of the skilled person in the art to adjust the amount of each element so as to reach a total of 1000 wt%.

[0010] The platinum based alloy does not contain any gallium. The absence of gallium results in lowering the solidification interval; a narrow window may allow avoiding chemical segregating or other defects. It also results in avoiding premature hardening during brazing, welding..., which usually leads to uneven properties and flaws.

45 **[0011]** The platinum based alloy is therefore constituted of Pt; Mn and/or V; Pd and/or Cr; and at least one of Ir, Cu, Au, Fe, Al, W, Rh, Ge and Y.

[0012] The platinum based alloy may contain impurities. However, the amount of impurities is generally insignificant as it does not amount to more than 500 ppm in weight, more preferably no more than 100 ppm, and even more preferably no more than 50 ppm.

50 **[0013]** Unless otherwise stated, quantities of element(s) are expressed in weight per thousand (wt%) or in parts per million in weight (ppm) with respect to the weight of the platinum based alloy. In other terms, 850 wt% or more of platinum means that, for 1000 parts by weight of platinum based alloy, said alloy contains at least 850 parts by weight of platinum i.e. at least 85 wt%.

[0014] Unless otherwise stated, all numerical ranges include the end-points. For instance, the numerical range "from 0.1 wt% to 100 wt%" includes the 0.1 and 100 wt% values.

55 **[0015]** Unless otherwise stated, all numerical ranges include any combination of the end-points of a range with the end-points of another range. For instance, "0.1 wt% to 100 wt%, preferably 0.1 wt% to 50 wt%, more preferably 1 wt% to 50 wt%, even, more preferably 1 wt% to 25 wt%" also includes the 0.1 wt% to 25 wt% range.

[0016] The alloy according to the invention has a homogeneous composition; the different elements are homogeneously spread within the alloy. It necessarily contains at least 4 elements: Pt, first alloying element, second alloying element and third alloying element. It may contain up to 14 elements: Pt; Mn and V (first alloying element); Pd and Cr (second alloying element); Ir, Cu, Au, Fe, Al, W, Rh, Ge and Y (third alloying element).

[0017] For instance, the alloy may comprise any one of the following combinations of elements:

- Pt, Mn, Pd and the third alloying element,
- Pt, Mn, Cr and the third alloying element,
- Pt, V, Pd and the third alloying element,
- Pt, V, Cr and the third alloying element.

[0018] As already mentioned, the third alloying element is at least one of Ir, Cu, Au, Fe, Al, W, Rh, Ge and Y.

[0019] As already mentioned, the platinum based alloy contains at least 850 wt% of platinum. However, according to a preferred embodiment, it may contain between 850 wt% and 990 wt% of platinum.

[0020] According to another preferred embodiment, it contains 950 wt% or more of platinum, preferably 953 wt% or more of platinum.

[0021] Although, the platinum based alloy may contain only one of manganese or vanadium, it may comprise both of these elements. Manganese and/or vanadium are usually added to the alloy in order to improve its hardness and its mechanical properties.

[0022] As already mentioned, the platinum based alloy contains from 0.1 wt% to 100 wt% of manganese and/or vanadium. It preferably contains between 0.1 wt% and 50 wt% of at least one of manganese and vanadium, more preferably between 1 wt% and 50 wt%, even more preferably between 5 wt% and 35 wt%.

[0023] The platinum based alloy may contain only one of palladium or chromium. Nevertheless, it may comprise both of these elements. Palladium and/or chromium may be added to the alloy in order to improve its casting properties.

Indeed, the melting point (or melting range) of the alloy can be adjusted by introducing more or less of Pd and/or Cr.

[0024] The platinum based alloy contains from 0.1 wt% to 100 wt% of palladium and/or chromium. It preferably contains between 0.1 wt% and 50 wt% of at least one of palladium and chromium, more preferably between 1 wt% and 50 wt%, even, more preferably between 1 wt% and 25 wt%.

[0025] In addition to Pt; Mn and/or V; Pd and/or Cr, the platinum based alloy also contains a non-zero quantity of at least one third alloying element, i.e. a non-zero quantity of any of iridium, copper, gold, iron, aluminum, tungsten, rhodium, germanium, yttrium and mixtures thereof. It preferably contains at least 0.01 wt% of third alloying element, more preferably at least 0.1 wt%. It may comprise no more than 50 wt% of third alloying element, even more preferably no more than 30 wt%, and even more preferably no more than 25 wt%. It can therefore comprise between 0.01 wt% and 30 wt% of third alloying element.

[0026] These elements can be introduced in order to improve the hardness and/or castability properties of the alloy as follows:

- Iridium: it allows increasing the hardness of the alloy. However, it degrades its castability since its presence may alter the fluidity and the form filling properties of the alloy.
- Copper: it allows narrowing the melting interval of the alloy while increasing its hardness.
- Gold: it slightly lowers the melting temperature of the alloy while increasing its hardness. However, it also increases the size grain of the alloy.
- Iron: it allows lowering the melting point of the alloy while increasing its hardness. However, its presence may alter the resistance to oxidation of the alloy.
- Aluminum: it allows lowering the melting point of the alloy. However, since it is poorly soluble within the alloy, the alloy preferably contains no more than 25 wt% of Al.
- Tungsten: it allows increasing the hardness. It also increases the melting point
- Rhodium: it allows increasing the mechanical properties of the alloy as well as its chemical resistance.
- Germanium: it allows increasing the hardness of the alloy. However, since it is poorly soluble within the alloy, the alloy preferably contains no more than 36 wt% of Ge.
- Yttrium: it allows lowering the melting point of the alloy while increasing its hardness and the fluidity of the melt. Due to the low solubility of Y in Pt, the alloy preferably contains no more than 1 wt% of Y.

[0027] Since the alloy according to the invention is preferably used in jewelry, its properties such as hardness or castability have to be controlled. Based on the above, the skilled person in the art will therefore adjust the amount of Ir, Cu, Au, Fe, Al, W, Rh, Ge and Y in order to obtain the desired properties.

[0028] According to a particular embodiment, the platinum based alloy may contain any one of the following combinations of alloying elements:

- iron, copper and aluminum, preferably in combination with manganese and chromium,
- copper and gold, preferably in combination with vanadium and palladium or with manganese and palladium,
- rhodium and iridium, preferably in combination with manganese and palladium,
- iron and copper, preferably in combination with manganese and chromium,
- iron, copper and yttrium, preferably in combination with vanadium and palladium,
- iron, tungsten and germanium, preferably in combination with manganese and palladium,
- iron, copper and germanium, preferably in combination with manganese and palladium,
- iron, germanium and yttrium, preferably in combination with manganese and palladium.

[0029] The alloy contains an amount of iridium that is preferably between 0.01 and 50 wt%, more preferably between 2 and 20 wt%, even more preferably between 3 and 19 wt%.

[0030] The alloy contains an amount of copper that is preferably between 0.01 and 50 wt%, more preferably between 3 and 13 wt%.

[0031] The alloy contains an amount of gold that is preferably between 0.01 and 50 wt%, more preferably between 4 and 22 wt%.

[0032] The alloy contains an amount of iron that is preferably between 0.01 and 50 wt%, more preferably between 3 and 12 wt%.

[0033] The alloy contains an amount of aluminum that is preferably between 0.01 and 25 wt%, more preferably between 15 and 25 wt%.

[0034] The alloy contains an amount of tungsten that is preferably between 0.01 and 50 wt%, more preferably between 9 and 11 wt%.

[0035] The alloy contains an amount of rhodium that is preferably between 0.01 and 50 wt%, more preferably between 3 and 11 wt%.

[0036] The alloy contains an amount of germanium that is preferably between 0.01 and 36 wt%, more preferably between 3 and 11 wt%.

[0037] The alloy contains an amount of yttrium that is preferably between 0.01 and 1 wt%.

[0038] The platinum based alloy is recyclable since it can be indefinitely shaped, melted and reshaped.

[0039] The platinum based alloy does not chemically interact with conventional molding apparatus. For instance, it does not react with gypsum.

[0040] According to another particular embodiment, the platinum based alloy has a Vickers hardness that preferably ranges between 80 and 350 HV, more preferably between 150 and 200HV.

[0041] According to another particular embodiment, the platinum based alloy has an elongation at break that can reach 30%.

[0042] According to another particular embodiment, the platinum based alloy has a porosity size that is preferably less than 100 μm , more preferably less than 50 μm , even more preferably less than 15 μm . The porosity size relates to the greatest dimension of a pore, for instance its diameter if a pore has the shape of a sphere.

[0043] According to another particular embodiment, the platinum based alloy has a porosity that is preferably less than 1%, more preferably less than 0.25%. The porosity relates to the total volume of pores in the alloy i.e. the volume of voids within a piece of alloy.

[0044] According to another particular embodiment, the platinum based alloy has a maximum grain size of 250 μm , preferably smaller than 150 μm . As a result of such a grain size, the items made of the platinum based alloy have a surface that does not show any flaws that are visible with the naked eye.

[0045] The above porosity and grain features may relate to the bulk form of the alloy or to a finished product resulting from the casting of the alloy.

[0046] According to another particular embodiment, the platinum based alloy has a melting temperature of less than 2000°C, preferably less than 1700°C.

The platinum based alloy is easily casted as it meets the conventional castability grid tests.

[0047] Its relatively narrow melting interval temperature, approximately 50°C, reduces, or prevents, the chemical segregation of the elements constituting the alloy.

[0048] This platinum based alloy can be prepared according to conventional techniques. The skilled person in the art will therefore be able to prepare this alloy based on the above description.

[0049] In general, the precursors of the platinum based alloy may be melted in an arc furnace or in an induction casting machine. The pure elements are first weighed, cleaned in an ultrasonic bath and then melted together, optionally under a controlled atmosphere.

[0050] Due to its properties, this platinum based alloy can be used in jewelry or in the watch industry to name a few. Indeed, the skilled person in the art will select the appropriate alloying element(s) in order to reach the desired castability and hardness while affording proper setting properties (jewelry) and/or resistance to scratches (watch).

[0051] The present invention also relates to an item comprising or consisting of the above platinum based alloy.

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Accordingly, this platinum based alloy can be used in order to manufacture luxury goods.

[0052] The item comprising or consisting of the above platinum based alloy can be a jewel, a leather good, or a clothing accessory. It may also be a watch, a writing accessory, or a decorative item. For instance, it can be any of the followings: ring, ear ring, necklace, bracelet, pendant, watch, buckle (belt, purse...), tie bar, cuff links, money clip, hair pin, pen, paper knife...

[0053] The invention and its advantages will become more apparent to one skilled in the art from the following examples.

EXAMPLES

[0054] Ten platinum based alloys (INV.1-10) have been prepared and compared to a conventional alloy (PtCuGa).

Table 1: Compositions (w%)

Alloy	Pt	Mn	V	Pd	Cr	Fe	Cu	Rh	Al	Au	Ir	W	Ge	Y	Total
INV.1	953	20			3	3	5		16						1000
INV.2	953		20	20			3			4					1000
INV.3	953	6		11				11			19				1000
INV.4	953	6		12			7			22					1000
INV.5	953	31		10				3			3				1000
INV.6	953	11			11	12	13								1000
INV.7	953		18	15		10	3							1	1000
INV.8	953	6		11		10						10	10		1000
INV.9	953	6		12		11	7						11		1000
INV.10	953	30		10		3							3	1	1000

[0055] Comparative example PtCuGa is an alloy comprising 953 w% Pt, 20 w% Cu and 27 w% Ga.

Table 2: Experimental results

Alloy	Hardness (HV)	Solidification temperature (°C)	Porosity (%)	Porosity size (μm)
PtCuGa	225±25	1220	0.26	16
INV.1	279±30	1400	0.49	51
INV.2	164±6	1550	0.01	51
INV.3	95±3	1800	0.05	51
INV.4	109±5	1600	0.15	39
INV.5	147±6	1800	0.04	22
INV.6	164±12	1420	0.02	9
INV.7	165±10	1420	0.01	3
INV.8	203±13	1490	0.48	27
INV.9	188±26	1410	0.14	15
INV.10	161±11	1500	0.53	11

[0056] Table 2 clearly shows that the alloy according to the invention affords similar or improved properties as compared to the conventional PtCuGa alloy.

Claims

1. Platinum based alloy consisting of:

- 850 wt% or more of platinum,
- from 0.1 wt% to 100 wt% of a first alloying element which is at least one of manganese and vanadium,
- from 0.1 wt% to 100 wt% of a second alloying element which is at least one of palladium and chromium,
- wherein the platinum based alloy necessarily contains at least a third alloying element in an amount of more than 0 wt% but less than 99.9 wt%, wherein the third alloying element is selected from the group consisting of iridium, copper, gold, iron, aluminum, tungsten, rhodium, germanium, yttrium, and mixtures thereof.

2. Platinum based alloy according to claim 1, wherein the platinum based alloy contains between 850 wt% and 990 wt% of platinum.

3. Platinum based alloy according to claim 1 or 2, wherein the platinum based alloy contains 950 wt% or more of platinum, preferably 953 wt% or more of platinum.

4. Platinum based alloy according to any one of claims 1 to 3, wherein the platinum based alloy contains any of the following combinations:

- platinum, manganese, palladium, and the third alloying element, or
- platinum, manganese, chromium, and the third alloying element, or
- platinum, vanadium, palladium, and the third alloying element, or
- platinum, vanadium, chromium, and the third alloying element.

5. Platinum based alloy according to any one of claims 1 to 4, wherein the platinum based alloy contains between 1 wt% and 50 wt% of at least one of manganese and vanadium.

6. Platinum based alloy according to any one of claims 1 to 5, wherein the platinum based alloy contains between 1 wt% and 50 wt% of at least one of palladium and chromium.

7. Platinum based alloy according to any one of claims 1 to 6, wherein the platinum based alloy contains between 0.01 wt% and 50 wt% of third alloying element, preferably between 0.01 wt% and 30 wt%.

8. Platinum based alloy according to any one of claims 1 to 7, wherein the third alloying element is at least one element selected from the group consisting of iridium, copper, gold, iron, aluminum, tungsten, rhodium, germanium, yttrium, and mixtures thereof,

wherein

when the third alloying element is at least iridium, the platinum based alloy contains between 0.01 and 50 wt% of iridium,

when the third alloying element is at least copper, the platinum based alloy contains between 0.01 and 50 wt% of copper,

when the third alloying element is at least gold, the platinum based alloy contains between 0.01 and 50 wt% of gold,

when the third alloying element is at least iron, the platinum based alloy contains between 0.01 and 50 wt% of iron,

when the third alloying element is at least aluminum, the platinum based alloy contains between 0.01 and 25 wt% of aluminum,

when the third alloying element is at least tungsten, the platinum based alloy contains between 0.01 and 50 wt% of tungsten,

when the third alloying element is at least rhodium, the platinum based alloy contains between 0.01 and 50 wt% of rhodium,

when the third alloying element is at least germanium, the platinum based alloy contains between 0.01 and 36 wt% of germanium,

when the third alloying element is at least yttrium, the platinum based alloy contains between 0.01 and 1 wt% of yttrium.

9. Platinum based alloy according to any one of claims 1 to 8, wherein the third alloying element is at least one element selected from the group consisting of iridium, copper, gold, iron, aluminum, tungsten, rhodium, germanium, yttrium, and mixtures thereof, wherein

when the third alloying element is at least iridium, the platinum based alloy contains between 2 and 20 wt% of iridium,
 when the third alloying element is at least copper, the platinum based alloy contains between 3 and 13 wt% of copper,
 when the third alloying element is at least gold, the platinum based alloy contains between 4 and 22 wt% of gold,
 when the third alloying element is at least iron, the platinum based alloy contains between 3 and 12 wt% of iron,
 when the third alloying element is at least aluminum, the platinum based alloy contains between 15 and 25 wt% of
 aluminum,
 when the third alloying element is at least tungsten, the platinum based alloy contains between 9 and 11 wt% of
 tungsten,
 when the third alloying element is at least rhodium, the platinum based alloy contains between 3 and 11 wt% of
 rhodium,
 when the third alloying element is at least germanium, the platinum based alloy contains between 3 and 11 wt%
 of germanium,
 when the third alloying element is at least yttrium, the platinum based alloy contains between 0.01 and 1 wt% of yttrium.

10. Platinum based alloy according to any one of claims 1 to 9, wherein the platinum based alloy contains any one of
 the following combinations of alloying elements:

- iron, copper and aluminum, preferably in combination with manganese and chromium,
- copper and gold, preferably in combination with vanadium and palladium,
- copper and gold, preferably in combination with manganese and palladium,
- rhodium and iridium, preferably in combination with manganese and palladium,
- iron and copper, preferably in combination with manganese and chromium,
- iron, copper and yttrium, preferably in combination with vanadium and palladium,
- iron, tungsten and germanium, preferably in combination with manganese and palladium,
- iron, copper and germanium, preferably in combination with manganese and palladium,
- iron, germanium and yttrium, preferably in combination with manganese and palladium.

11. Jewel comprising the platinum based alloy according to any one of claims 1 to 10.

12. Leather good comprising the platinum based alloy according to any one of claims 1 to 10.

13. Clothing accessory comprising the platinum based alloy according to any one of claims 1 to 10.

14. Use of the platinum based alloy according to any one of claims 1 to 10 in the watch industry.

15. Use of the platinum based alloy according to any one of claims 1 to 10 in the jewelry industry.



EUROPEAN SEARCH REPORT

Application Number
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Place of search Munich		Date of completion of the search 19 January 2018	Examiner Liu, Yonghe
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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