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(71) Applicant: **Richemont International SA**
1752 Villars-sur-Glane (CH)

(72) Inventors:
- **COLAS, Damien**
  2830 COURRENDLIN (CH)
- **DIOLOGENT, Frédéric**
  2000 NEUCHATEL (CH)
- **VAN DER LINGEN, Elma**
  JOHANNESBURG (ZA)
- **SIGALAS, Iakovos**
  BROMHOF, RANDBURG (ZA)
- **ROCKEBRAND, Patrick**
  WALKERVILLE (ZA)
- **TSHEPHE, Thato**
  SHARONLEA, RANDBURG (ZA)

(74) Representative: **Peguet, Wilfried**
Ipsilon
Le Centralis
63, avenue du Général Leclerc
92340 Bourg-la-Reine (FR)

(54) PLATINUM COMPOSITE COMPRISING INTERMETALLIC PLATINUM PARTICLES

(57) The present invention concerns a platinum composite characterized in that it comprises intermetallic platinum particles (1) and a platinum matrix (2).

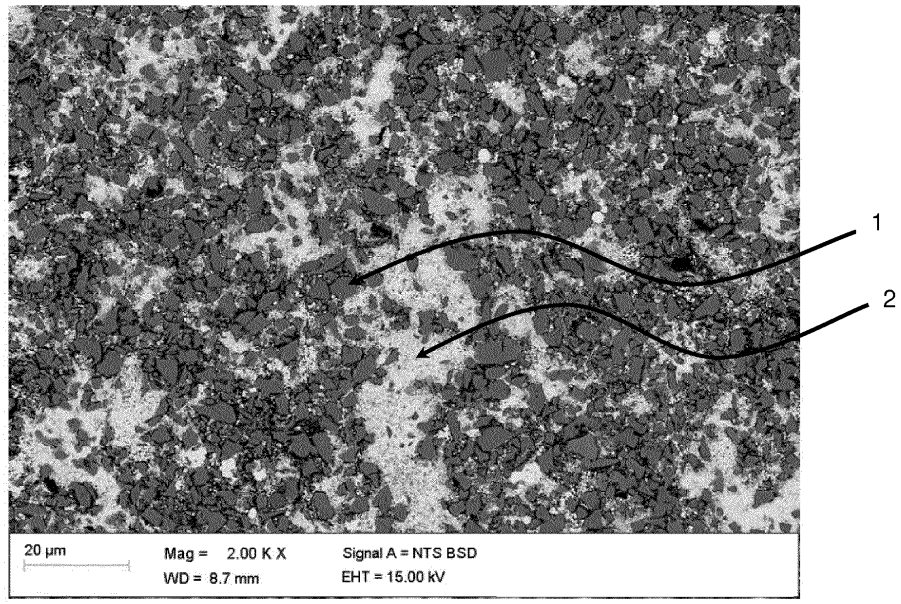

FIG.1

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Description

[0001] The present invention relates to a platinum composite comprising intermetallic platinum particles, and to a process of manufacturing said platinum composite.

[0002] More particularly, the platinum composite is used to manufacture luxury goods.

[0003] Platinum itself has a plain silver color and, in consequence, is not considered to be particularly appealing for use in the jewellery trade. Furthermore, certain intermetallic platinum compounds, particularly those with aluminum, do have colors different from that of the constituent metals.

[0004] Some attention has been given to intermetallic compounds, that provide color. One can cite the document EP-0 421 731 concerning intermetallic compounds of platinum and aluminum.

[0005] However, such intermetallic compounds do not present optimized mechanical properties, so that they are easily brittle and difficult to shape.

[0006] The present invention seeks to provide a platinum composite, more particularly obtained from an intermetallic platinum compound, having optimized mechanical properties, while being easy to shape.

[0007] To this end, an object of the present invention is a platinum composite comprising intermetallic platinum particles and a platinum matrix, the intermetallic platinum particles including preferably platinum (Pt) and at least one metallic element different from platinum (Pt).

[0008] The present invention advantageously provides a platinum composite with an optimized hardness, so that improving its shaping, especially to manufacture luxury good.

[0009] The platinum composite of the present invention can also provide aesthetically appealing colors, and render it attractive and appealing for use as luxury good as such or as component parts of luxury good.

[0010] Furthermore, the present invention advantageously can also provide a platinum composite with an improved toughness, while being easy to shape.

[0011] The platinum composite of the invention comprises a platinum matrix and intermetallic platinum particles.

[0012] More particularly, the platinum matrix can be positioned at the interface between the intermetallic platinum particles in the platinum composite.

[0013] The presence of the platinum matrix and the intermetallic platinum particles together in the platinum composite aims at forming at least two different crystallographic phases in the platinum composite.

[0014] More particularly, the platinum composite comprises at least one platinum phase of platinum matrix, and at least one intermetallic phase of intermetallic platinum particles.

[0015] The platinum composite can comprise at least 70.0% by weight of platinum (Pt), and preferably at least 80.0% by weight of platinum (Pt), over the total weight of the platinum composite.

[0016] The platinum composite can comprise at least 85.0% by weight of platinum (Pt), and more preferably at least 90.0% by weight of platinum (Pt), over the total weight of the platinum composite.

[0017] In the present description, the amount of platinum (Pt) expressed in % (percentage) by weight over the total weight of the platinum composite can also be expressed in ‰ (per mille) by weight over the total weight of the platinum composite. For example, 85.0% by weight of platinum (Pt) over the total weight of the platinum composite can be written as 850 ‰ by weight over the total weight of the platinum composite.

[0018] The amount of platinum (Pt) in the platinum composite can be easily determined by X-ray fluorescence (XRF).

[0019] When the platinum composite comprises at least 85.0% by weight of platinum (Pt) over the total weight of the platinum composite, the platinum composite can be advantageously hallmarked, by technic well-known in the art.

[0020] In the present invention, the expression "intermetallic" means a compound exhibiting metallic bonding, with a defined stoichiometry and an ordered crystal structure.

[0021] In other words, an intermetallic compound consists of the periodic alternation of atoms, and more particularly metallic atoms.

[0022] In a particular embodiment, the intermetallic platinum compound can have a crystal system of face-centered cubic type. In such crystal system, the fluorite crystallographic structure type (CaF_2) is preferred.

[0023] The intermetallic platinum particles of the platinum composite can be obtained or made from an intermetallic platinum compound including platinum (Pt) and at least one metallic element different from platinum (Pt), the intermetallic platinum compound being in the form of particles.

[0024] The metallic element can be selected among alkali metal, alkaline earth metal, transition metal, post-transition metal, and a combination thereof.

[0025] For example, the alkali metal can be lithium (Li); the alkaline earth metal can be magnesium (Mg); the transition metal can be copper (Cu); the post-transition metal can be aluminum (Al), gallium (Ga), indium (In), tin (Sn).

[0026] The metallic element which can be used to obtained the intermetallic platinum compound can have a purity of at least 99.00 % by weight, and more preferably of at least 99.50 % by weight, over the total weight of metallic element. In a particular embodiment, the intermetallic platinum compound can further include at least one metalloid element, such as for example antimony (Sb).

[0027] The preferred intermetallic platinum compound used in the present invention can be selected among: $PtAl_2$, $PtAl_2Cu$, Pt_2Al_3, PtAl, $PtLi_2Al$, $PtLi_2In$, $PtLi_2Sn$, PtMgSn, $PtLiAl_2$, $PtLiGa_2$, PtMgSb, and any mixture thereof.

[0028] The most preferred intermetallic platinum compounds are $PtAl_2$ or $PtAl_2Cu$. In a particular embodiment, the primitive cell of $PtAl_2Cu$ is at least 0,5 % higher than the primitive cell of $PtAl_2$, and more preferably is around 0,8 % higher than the primitive cell of $PtAl_2$.

[0029] The intermetallic platinum particles of the present invention can be of micrometric size, or in other words can be microparticles.

[0030] The intermetallic platinum particles are typically of micrometric (10^{-6} meter) size in at least one of their dimensions.

[0031] The dimension of one intermetallic platinum particle, or in other words the dimension of one elementary intermetallic platinum particle, is determined in using the equivalent circular diameter in which a circumscribed circle of the particle is a circle which passes through all the vertices of the particle.

[0032] The dimension of one intermetallic platinum particle can be determined conventionally by methods that are well known to the person skilled in the art, such as by analyzing images taken using a microscope, in particular a scanning electron microscope (SEM).

[0033] The dimension of one or several intermetallic platinum particle(s) of the invention can be at most 300 micrometers (μm), more preferably at most of 100 μm, more preferably at most of 50 μm, and even more preferably at most of 10 μm.

[0034] The dimension of one or several intermetallic platinum particle(s) of the invention can be at least of 0.1 μm, more preferably at least of 0.5 μm, and even more preferably at least of 1 μm.

[0035] The intermetallic platinum particles, comprised in the platinum composite, include more than 50% by weight of microparticles, and more preferably more than 80% by weight of microparticles, over the total weight of intermetallic platinum particles.

[0036] In the platinum composite of the present invention, the amount of intermetallic platinum particles can be expressed as follows.

[0037] The platinum composite can comprise at most 90.0 % by weight of intermetallic platinum particles, and more preferably at most 80.0 % by weight of intermetallic platinum particles, over the total weight of the platinum com posite.

[0038] The platinum composite can comprise at least 10.0 % by weight of intermetallic platinum particles, and more preferably at least 20.0 % by weight of intermetallic platinum particles, over the total weight of the platinum com posite.

[0039] The amount of intermetallic platinum particles in the platinum composite can be easily determined by Scanning Electron Microscopy (SEM).

[0040] The platinum matrix of the invention can be composed of platinum (Pt).

[0041] More particularly, the platinum matrix is not an intermetallic platinum compound, so that the platinum matrix is different from the intermetallic platinum particles of the invention.

[0042] In the present invention, the platinum matrix can be continuous or not, at the entire scale of the platinum composite.

[0043] The platinum matrix can comprise more than 50.0 % by weight of platinum (Pt), more preferably at least 80.0 % by weight of platinum (Pt), more preferably at least 90.0 % of platinum (Pt), and even more preferably at least 98.0 % by weight of platinum (Pt), over the total weight of the platinum matrix. More preferably, the platinum matrix only comprises platinum (Pt).

[0044] In the platinum composite of the present invention, the amount of platinum matrix can be expressed as follows.

[0045] The platinum composite can comprise at most 90.0 % by weight of platinum matrix, more preferably at most 80.0 % by weight of platinum matrix, and even more preferably at most 65.0 % by weight of platinum matrix, over the total weight of the platinum composite.

[0046] The platinum composite can comprise at least 10.0 % by weight of platinum matrix, and more preferably at least 20.0 % by weight of platinum matrix, over the total weight of the platinum composite.

[0047] The amount of platinum matrix in the platinum composite can be easily determined by Scanning Electron Microscopy (SEM).

[0048] When the platinum composite comprises an amount of intermetallic platinum particles superior to the amount of platinum matrix, it can be said that the platinum matrix is dispersed in the intermetallic platinum particles.

[0049] When the platinum composite comprises an amount of platinum matrix superior to the amount of intermetallic platinum particles, it can be said that the intermetallic platinum particles is dispersed in the platinum matrix.

[0050] In the present invention, the intermetallic platinum particles are more particularly made from an intermetallic platinum compound which comprises platinum (Pt) and one or several metallic element(s).

[0051] Another object of the present invention is a process of manufacturing a platinum composite, more particularly a process of manufacturing the platinum composite of the present invention.

[0052] The platinum composite is more preferably obtained from a composition comprising platinum (Pt) particles and an intermetallic platinum compound.

[0053] The platinum (Pt) particles of the invention can be composed of platinum (Pt) with a purity of at least 99.00 %

by weight, and more preferably of at least 99.50 % by weight, over the total weight of platinum particles.

[0054] The platinum (Pt) particles can be mixed with the intermetallic platinum compound, in order to obtain the platinum composite.

[0055] The platinum particles can be of micrometric size, or in other words can be microparticles.

[0056] The platinum particles are typically of micrometric (10^{-6} meter) size in at least one of their dimensions.

[0057] The dimension of one platinum particle, or in other words the dimension of one elementary platinum particle, is determined in using the equivalent circular diameter in which a circumscribed circle of the particle is a circle which passes through all the vertices of the particle.

[0058] The dimension of one platinum particle can be determined conventionally by methods that are well known to the person skilled in the art, such as by analyzing images taken using a microscope, in particular a scanning electron microscope (SEM).

[0059] The dimension of one or several platinum particle(s) of the invention can be at most of 300 micrometers (μm), more preferably at most of 100 μm, more preferably at most of 50 μm, and even more preferably at most of 10 μm.

[0060] The dimension of one or several platinum particle(s) of the invention can be at least of 0.1 μm, more preferably at least of 0.5 μm, and even more preferably at least of 1 μm.

[0061] The platinum particles include more than 50% by weight of microparticles, and more preferably more than 80% by weight of microparticles, over the total weight of platinum particles.

[0062] The intermetallic platinum compound can be the one described in the present invention.

[0063] The intermetallic platinum compound can comprise more than 50.0 % by weight of platinum (Pt), and more preferably at least 60.0 % by weight of platinum (Pt), over the total weight of the intermetallic platinum compound.

[0064] The intermetallic platinum compound can comprise less than 95.0 % by weight of platinum (Pt), more preferably less than 85.0 % by weight of platinum (Pt), and even more preferably less than 80.0 % by weight of platinum (Pt), over the total weight of the intermetallic platinum compound.

[0065] The intermetallic platinum compound used to obtain the platinum composite can be in the form of particles, and more preferably in the form of microparticles, as described in the present invention.

[0066] The colors of the above-mentioned intermetallic platinum compounds are listed in the below table 1 :

Table 1

$PtAl_2$	Yellow
$PtAl_2Cu$	Orange or pink
Pt_2Al_3	Blue
PtAl	Grey
$PtLi_2Al$	Bright-yellow
$PtLi_2In$	Brass-yellow
$PtLi_2Sn$	Yellow
PtMgSn	Reddish-brown
$PtLiAl_2$	Copper-red
$PtLiGa_2$	Brown-pink
PtMgSb	Violet

[0067] The intermetallic platinum compound can preferably be in the form of particles or powder, mixed with the platinum (Pt) particles, in order to obtain the platinum composite.

[0068] The particles of intermetallic platinum compound, and more preferably the microparticles of intermetallic platinum compound, can be those described in the present invention.

[0069] The process of manufacturing a platinum composite can comprise the following steps:

i. mixing an intermetallic platinum compound and platinum (Pt) particles, the intermetallic platinum compound comprising more preferably platinum (Pt) and at least one metallic element different from platinum (Pt), and
ii. sintering the mixture obtained in step i.

[0070] In a preferred embodiment, the process aims at manufacturing the platinum composite according to the invention.

[0071] The step i can be performed by well-known technics in the art, especially to mix microparticles. For example, the intermetallic platinum compound, preferably under the form of particles, and the platinum particles can be mixed together in using an ultrasonic bath with the addition of one solvent, such as acetone. The mixing time can be done during a sufficient time to obtained a homogenized mixture. For example, the mixture time can be from 1 to 20 minutes.

[0072] The step i is a mixing step of a composition comprising the intermetallic platinum compound and the platinum (Pt) particles.

[0073] The composition can comprise more than 50.0% by weight of platinum (Pt), more preferably at least 70.0% by weight of platinum (Pt), and even more preferably at least 80.0% by weight of platinum (Pt), over the total weight of the composition.

[0074] The composition can comprise at least 85.0% by weight of platinum (Pt), and more preferably at least 90.0% by weight of platinum (Pt), over the total weight of the composition.

[0075] In step i of the present invention, the amount of intermetallic platinum compound can be expressed as follows.

[0076] The composition can comprise at most 90.0 % by weight of intermetallic platinum compound, more preferably at most 80.0 % by weight of intermetallic platinum particles, and even more preferably at most 70.0 % by weight of intermetallic platinum particles, over the total weight of the composition.

[0077] The composition can comprise at least 10.0 % by weight of intermetallic platinum particles, and more preferably at least 20.0 % by weight of intermetallic platinum particles, over the total weight of the composition.

[0078] In step i of the present invention, the amount of platinum (Pt) particles can be expressed as follows.

[0079] The composition can comprise at most 80.0 % by weight of platinum (Pt) particles, and more preferably at most 65.0 % by weight of platinum (Pt) particles, over the total weight of the composition.

[0080] The composition can comprise at least 10.0 % by weight of platinum (Pt) particles, and more preferably at least 20.0 % by weight of platinum (Pt) particles, over the total weight of the composition.

[0081] In a preferred embodiment, the platinum particles are not an intermetallic platinum compound, so that the platinum particles are different from the intermetallic platinum compound of the invention.

[0082] The step ii can be done in using a plasma sintering furnace or in using another equipment well-known in the art.

[0083] In the sintering step ii, different parameters can vary, such as the sintering temperature, the sintering dwell time, and/or the sintering pressure.

[0084] In a particular embodiment, the sintering step ii can include one or several of the following parameters:

- the sintering temperature can be from 450 to 850 °C, and/or
- the sintering dwell time can be from 1 to 10 minutes (min), and more preferably from 2 to 7 minutes, and/or
- the sintering pressure can be from 200 to 400 MPa.

[0085] With a sintering temperature less than 450°C and/or a sintering pressure less than 200 MPa, the platinum composite can present mechanical properties which are not optimized, especially in terms of brittleness and/or weak densification.

[0086] With a sintering temperature more than 850°C and/or a sintering pressure more than 400 MPa, the platinum composite can present a loss of color.

[0087] Before step i, the intermetallic platinum compound can be milled by technic well-known in the art to form particles or powder, as described in the present invention.

[0088] The intermetallic platinum compound used in the process of manufacturing a platinum composite, can be manufactured before step i.

[0089] The process of manufacturing an intermetallic platinum compound is well known in the art. For example, the intermetallic platinum compound used in the present invention can be the one described in EP-0 421 731.

[0090] More particularly, the process of manufacturing an intermetallic platinum compound can comprise the following step:

a.mixing at least two different metallic powders including platinum and at least one metallic element different from platinum, more preferably the mixing step being a dry mixing;
b. melting the mixture obtained in step a, and more preferably arc melting the mixture obtained in step a,

to obtain said intermetallic platinum compound, more preferably in the form of solid element(s), such as for example in the form of ingot(s).

[0091] The step b can be done using an arc melter, more preferably under an argon atmosphere.

[0092] In a preferred embodiment, the step b can be performed at least twice, in order to obtain said intermetallic platinum compound with an enhanced homogeneity.

[0093] The intermetallic platinum compound of the present invention, obtained from steps a and b, or obtained from another process well-known in the art, can undergo a treatment process before step i, which can include a thermic

treatment and/or a mechanic treatment.

[0094] More particularly, the process of treating of the intermetallic platinum compound can comprise at least one of the following steps, before step i, and after step b when step b exists:

c. annealing the intermetallic platinum compound, as thermic treatment, and/or
d. milling the intermetallic platinum compound, as mechanic treatment.

[0095] In a preferred embodiment, the process of treating of the intermetallic platinum compound can comprise the following steps, before step i, and after step b when step b exists:

c. annealing the intermetallic platinum compound, and
d. milling the intermetallic platinum compound obtained in step c.

[0096] In the present invention, the step c can be performed in using a furnace, and more preferabley a muffle furnace. The temperature in step c can be from 800 to 1200°C, and more preferably around 1000°C.

[0097] The step d can be done using a mortar and pestle and/or a planetary ball mill. This step can allow to obtain particles of intermetallic platinum compound as described in the present invention.

[0098] In a particular embodiment, when the intermetallic platinum compound is manufactured according to the steps a and b as described in the present invention, the step c is done after step b.

[0099] Another object of the present invention is a platinum composite obtained from the process of manufacturing a platinum composite as described in the present invention.

[0100] Another object of the present invention is an item obtained from the platinum composite.

[0101] The item can comprise or consist of the platinum composite according to the present invention. Accordingly, this platinum composite can be used in order to manufacture luxury goods, such as for example a time-piece and/or a jewel. The time-piece and/or the jewel can have a part or a component comprising the platinum composite according to the present invention.

[0102] The item according to the present invention can be a jewel, a leather good, or a clothing accessory. It may also be a watch, a writing accessory, or a decorative item.

[0103] For instance, the item can be any of the followings: ring; ear ring; necklace; bracelet; pendant; watch such as case, bezel, caseback, crown, bracelet links, clasp, buckle, automatic movement rotor; buckle (e.g. belt or purse); tie bar; cuff links; money clip; hair pin; pen; paper knife.

[0104] The present invention will become more fully understood from the examples given herein below and from the accompanying drawing, which are given by way of illustration only, and thus, which are not limits of the present invention, and wherein:

Figure 1 represents a SEM picture of a platinum composite according to the invention.

Examples:

1. Process of manufacturing an intermetallic platinum compound

[0105] Different intermetallic platinum compounds have been prepared and are gathered in the Table 2 as below.

[0106] The amounts in Table 2 are expressed in percentage by weight (wt%) over the total weight of the intermetallic platinum compound.

[0107] The right column of Table 2 presents the color of each intermetallic platinum compound.

Table 2

	Platinum (Pt) powder	Aluminum (Al) powder	Copper (Cu) powder	Color
Intermetallic platinum compound 1	77.0 wt%	23.0 wt%	0 wt%	Yellow
Intermetallic platinum compound 2	61.6 wt%	18.4 wt%	20.0 wt%	Pink

[0108] The origin of the different powders mentioned in table 2 is as follows:

- Platinum powder is commercialized by Impala Platinum Ltd, with a purity of 99,95 % and a particle diameter size

around 84 μm (equivalent circular diameter);

- Aluminum powder is a commercialized aluminum powder with a purity of 99,00 % and a particle diameter size from 10 to 100 μm (equivalent circular diameter); and
- Copper powder is a commercialized copper powder with a purity of 99,00 % and a particle diameter size from 10 to 100 μm (equivalent circular diameter).

[0109] The intermetallic platinum compounds 1 and 2 of Table 2 are obtained as follows.

[0110] In a first step (step a), the platinum powder, the aluminum powder, and optionally the copper powder, are dry mixed in using a spatula in a petri dish.

[0111] In a second step (step b), the mixture obtained in step a is melted in using an arc melter (under argon atmosphere, with a potential of 24 V and a current of 320-380 A), to form ingots of intermetallic platinum compound (i.e. intermetallic platinum ingots). Then, the ingots are re-melted two times in order to enhance homogeneity.

[0112] Thus in step b, the obtained intermetallic platinum compound 1 is $PtAl_2$, and the obtained intermetallic platinum compound 2 is $PtAl_2Cu$.

2. Process of treating the intermetallic platinum compound

[0113] After forming the intermetallic platinum compound in step b as above, in a third step (step c) the intermetallic platinum ingots are annealed at a temperature of 1000°C for 30 minutes.

[0114] More particularly, the intermetallic platinum ingots are sealed in a quartz glass tube under 0.2 atm of argon gas and placed in a furnace. The temperature of the furnace raises to 1000°C at a heating rate of 5°C/min, and the ingots are kept at 1000°C for 30 minutes, and then quenched in water.

[0115] In a fourth step (step d), the annealed ingots are milled into fine particles to form a powder, in using a Fritsch Pulverisette 6 planetary mono Ball mill device (milling conditions: hexane as solvent; milling speed of 300 rpm; duration: 3 hours). The obtained intermetallic platinum powder are microparticles with a diameter size (i.e. equivalent circular diameter) from 1 to 10 μm, and more particularly around 3 μm.

3. Process of manufacturing a platinum composite

[0116] In a fifth step (step i), platinum (Pt) particles (powder) are used, this platinum powder being commercialized by Impala Platinum Ltd, with a purity of 99,95% and a particle diameter size around 84 μm (i.e. equivalent circular diameter).

[0117] The Table 3 as below gathers the amount of the platinum (Pt) particles, the intermetallic platinum compound 1 and the intermetallic platinum compound 2 used in the manufacturing of the Components 1 to 6.

[0118] Component 1 and Component 4 are obtained from the powders of intermetallic platinum compounds prepared in steps a to d, without the addition of platinum particles.

[0119] Component 2, Component 3, Component 5, and Component 6 are obtained from the powders of intermetallic platinum compounds prepared in steps a to d, with the addition of the platinum particles.

[0120] The amounts in Table 3 are expressed in gram (g) over 2 grams of component. The total weight of platinum (Pt) in the component is expressed in percentage by weight (wt%) over the total weight of the component.

Table 3

	Platinum (Pt) particles	Intermetallic platinum compound 1 ($PtAl_2$)	Intermetallic platinum compound 2 ($PtAl_2Cu$)	Total weight of platinum in the component
Component 1	0 g	2.000 g	0 g	77.0 wt%
Component 2	0.260 g	1.740 g	0 g	80.0 wt%
Component 3	0.696 g	1.304 g	0 g	85.0 wt%
Component 4	0 g	0 g	2.000 g	61.6 wt%
Component 5	0.958 g	0 g	1.042 g	80.0 wt%

(continued)

	Platinum (Pt) particles	Intermetallic platinum compound 1 ($PtAl_2$)	Intermetallic platinum compound 2 ($PtAl_2Cu$)	Total weight of platinum in the component
Component 6	1.218 g	0 g	0.782 g	85.0 wt%

[0121] Component 2, 3, 5 and 6 (i.e. platinum composite according to the invention) are obtained in mixing together the powder of platinum (Pt) and the powder of intermetallic platinum compound, listed in Table 3.

[0122] The mixing is done for 10 minutes, in using an ultrasonic bath with the addition of acetone as solvent. Then, the mixture is dried to evaporate the solvent at a temperature of 30°C.

[0123] In a sixth step (step ii), the mixture obtained in step i is then sintered using a furnace with the following commercialized reference: FCT System HP-D5 spark plasma sintering furnace. The sintering is performed under vacuum, with an absolute gas pressure of 1 hPa, and with a pulse time (i.e. duration of the electric discharge through the sample) of 10 ms with a pause of 5 ms.

[0124] The Components 1 and 4 are also sintered under the same conditions as Components 2, 3, 5 and 6.

[0125] The temperature and pressure of the sintering step are gathered in the following Table 4. The sintering dwell time vary between 2 and 7 minutes, the sintering dwell time being the amount of time during which the pressure and temperature are applied.

Table 4

	Temperature (°C)	Pressure (MPa)
Component 1	850	200
Component 2	450	250
Component 3	850	200
Component 4	650	250
Component 5	450	250
Component 6	500	200

Determination method of the particle size

[0126] The particle size (i.e. equivalent circular diameter) of the Components 1 to 6 has been determined by the following method.

[0127] To illustrate one of the obtained platinum composite, Figure 1 represents a SEM picture of the Component 6 obtained with a temperature of 500°C and a pressure of 200 MPa, during 2 minutes (sintering step).

[0128] Figure 1 shows intermetallic platinum particles (1) together with the platinum matrix (2) as solid phase between the interfaces of the intermetallic platinum particles.

[0129] The size of the intermetallic platinum particles in the components 1 to 6 are from 1 to 10 μm.

Determination method of the color

[0130] In order to evaluate the color of the Components 1 to 6, the CI ELAB coordinates, which are well known as color space specified by the International Commission on Illumination (known in French with the acronym CIE), are used.

[0131] The three coordinates of CI ELAB represent the lightness of the color (L* = 0 yields black and L* = 100 indicates diffuse white), its position between red/magenta and green (a*, negative values indicate green while positive values indicate magenta) and its position between yellow and blue (b*, negative values indicate blue and positive values indicate yellow).

[0132] For example, L* a* b coordinates of the "Traditional" 5N gold alloy (Composition : Au 750w‰ + Ag 45w‰ + Cu 205w‰) is as follows: L* = 86.3; a* = 8.8; b* = 18.5.

[0133] To compare two different colors, or to characterize the evolution of a sample, the expression "ΔE*" can be used. ΔE corresponds to the distance between two colors placed in the CIELAB color space which is calculated with the formula of the Euclidian distance.

[0134] "ΔE*" is classically known as follows:

$$\Delta E^* = \sqrt{(L_2^* - L_1^*)^2 + (a_2^* - a_1^*)^2 + (b_2^* - b_1^*)^2}$$

wherein: L_1^* , a_1^* , b_1^* are the coordinates of the first color to compare, and L_2^*, a_2^*, b_2^* are the coordinates of the second color to compare.

[0135] The illuminant used to evaluate the platinum composite color is the CIE D65 standard illuminant, with a viewing angle of 10°.

[0136] The CIELAB coordinates of the Components 1 to 6 are gathered in the following Table 5.

Table 5

	CI ELAB corrdinates with CIE standard illuminant D65		
	L*	a*	b*
Component 1	77.98±0.32	5.57±0.1	24.01±0.51
Component 2	77.02±0.29	2.60±0.05	9.94±0.28
Component 3	65.52±0.36	3.11±0.06	9.31±0.12
Component 4	77.70±0.19	8.79±0.04	10.84±0.16
Component 5	79.98±0.24	4.74±0.05	8.35±0.06
Component 6	74.92±0.41	1.02±0.06	6.13±0.19

[0137] According to the results of Table 5, the Components 2, 3, 5 and 6 according to the present invention provide aesthetically appealing colors, and render it attractive and appealing for use as luxury good as such or as component parts of luxury good.

Determination method of the hardness

[0138] The hardness of the Components 1, 2, 4 and 5 have been determined using a Vickers micro-hardness tester on polished samples. The samples have been indented linearly on the surfaces at five different positions and the average have been recorded. The indentation load was 2 kg with an indentation time of 10 seconds.

[0139] In the present invention, the hardness of the platinum composite, comprising intermetallic platinum particles and a platinum matrix, can advantageously be lower than the hardness of said intermetallic platinum particles as such. More particularly, the hardness of the platinum composite according to the present invention can be of at least 200 Hv.

[0140] The hardness of the Components 1, 2, 4 and 5 are gathered in the following Table 6.

Table 6

	Hardness (Hv)
Component 1	488 ± 5
Component 2	297 ± 13
Component 4	355 ± 30
Component 5	294 ± 27

[0141] The hardness of Component 2 is lower than the hardness of Component 1, and the hardness of Component 5 is lower than the hardness of Component 4. Hence, the present invention advantageously provides a platinum composite with an optimized hardness, in comparison to intermetallic platinum compound as such, so that improving its shaping.

Claims

1. Platinum composite **characterized in that** it comprises:

- intermetallic platinum particles (1) including platinum (Pt) and at least one metallic element different from platinum (Pt), and
- a platinum matrix (2).

2. Platinum composite according to claim 1, **characterized in that** the platinum composite comprises at least 70.0 % by weight of platinum (Pt), and more preferably at least 80.0 % by weight of platinum (Pt), over the total weight of the platinum composite.

3. Platinum composite according to claim 1 or 2, **characterized in that** the platinum composite comprises at least 85.0 % by weight of platinum (Pt) over the total weight of the platinum composite.

4. Platinum composite according to any one of the preceding claims, **characterized in that** the intermetallic platinum particles are microparticles.

5. Platinum composite according to any one of the preceding claims, **characterized in that** the dimension of the intermetallic platinum particles is at most of 300 micrometers (μm), more preferably at most of 100 μm, more preferably at most of 50 μm, and even more preferably at most of 10 μm.

6. Platinum composite according to any one of the preceding claims, **characterized in that** the platinum composite comprises from 10.0 to 90.0 % by weight of intermetallic platinum particles over the total weight of the platinum composite.

7. Platinum composite according to any one of the preceding claims, **characterized in that** the platinum composite comprises from 10.0 to 90.0 % by weight of platinum matrix over the total weight of the platinum composite.

8. Process of manufacturing a platinum composite, **characterized in that** the process comprises the following steps:

i. mixing an intermetallic platinum compound including platinum (Pt) and at least one metallic element different from platinum, and platinum (Pt) particles, and
ii. sintering the mixture obtained in step i.

9. Process according to claim 8, **characterized in that** the step ii is done at a temperature from 450 to 850 °C.

10. Process according to claim 8 or 9, **characterized in that** the step ii is done at a pressure from 200 to 400 MPa.

11. Process according to any one of claims 8 to 10, **characterized in that** the platinum particles are composed of platinum (Pt) with a purity of at least 99.00 % by weight, and more preferably of at least 99.95 % by weight, over the total weight of platinum particles.

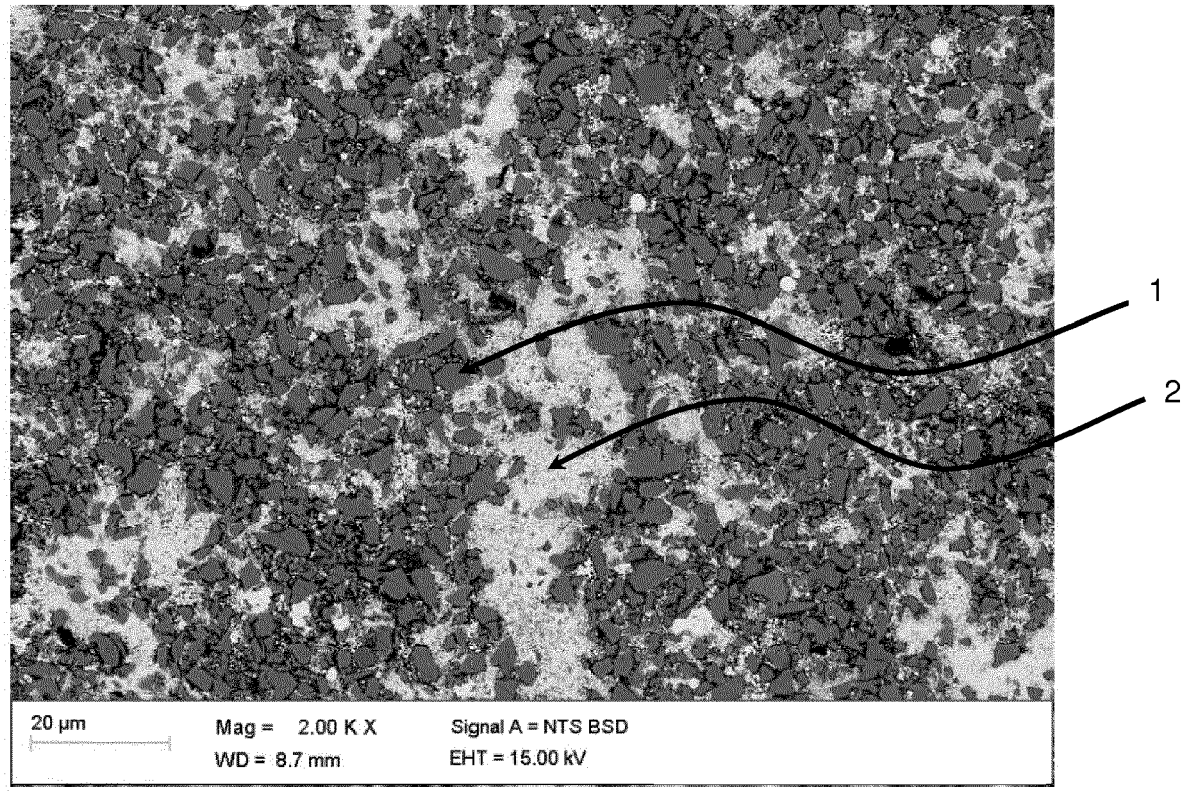
12. Process according to any one of claims 8 to 11, **characterized in that** the intermetallic platinum compound comprises more than 50.0 % by weight of platinum (Pt) over the total weight of the intermetallic platinum compound.

13. Process according to any one of claims 8 to 12, **characterized in that** the intermetallic platinum compound comprises less than 95.0 % by weight of platinum (Pt) over the total weight of the intermetallic platinum compound.

14. Process of treating an intermetallic platinum compound, **characterized in that** it comprises at least one of the following steps, before step i of the process of manufacturing a platinum composite according to any one of claims 8 to 13:

c. annealing the intermetallic platinum compound, and/or
d. milling the intermetallic platinum compound.

15. Time-piece or jewel having a part or a component comprising the platinum composite according to any one of claims 1 to 7.



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EUROPEAN SEARCH REPORT

Application Number
EP 18 15 7468

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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