A nickel-free platinum Alloy Composition

Introduction

The present invention relates to a platinum alloy composition, in particular a platinum alloy composition for use in jewellery and an alloy composition for jewellery with improved castability and suited to jewellery.

For jewellery applications, pure platinum is not hard enough. This leads to poor wear resistance but can also result in other issues such as jewellery that is prone to deformation and cannot securely hold set gemstones. To improve the hardness of platinum jewellery, pure platinum is alloyed with additional (alloying) elements. However, alloying elements can adversely affect the castability of the platinum alloy.

WO2022074363A1 describes alloys meeting similar objectives.

It is an aim of the present disclosure to provide a platinum alloy with suitable hardness for jewellery which has an improved balance of castability and solderability.

In an aspect, there is provided a platinum alloy composition consisting, in weight percent, of: 0.0 to 5.0 gold, 0.0 to 2.5 cobalt, 0.0 to 3.0 copper, 0.25 to 2.5 iron, 0.0 to 2.75 gallium, 0.0 to 3.0 indium, 0.0 to 5.0 iridium, 0.0 to 5.0 manganese, 0.0 to 5.0 palladium, 0.0 to 5.0 rhenium, 0.0 to 5.0 rhodium, 0.0 to 5.0 ruthenium, 0.0 to 3.0 tin, 0.0 to 5.0 silver, with the sum of platinum and iridium being 95.0 or more and 1.0 wt.% or less of incidental impurities, wherein the following equation 1 is satisfied in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, $W_{Rh,}$ $W_{Ir,}$ W_{Au}, W_{Ru} , W_{Re} , W_{Ag} and W_{Mn} are the weight percent of cobalt, copper, iron, gallium, indium, nickel, palladium, tin, rhodium, iridium, gold, ruthenium, rhenium, silver and manganese in the alloy respectively

$$60 + W_{Pd}*2.5 + W_{Rh}*3.4 + W_{Ir}*6.455 + W_{Au}*11.93 + W_{Ru}*13.241 + W_{Cu}*14.328 + W_{Re}*16.6 + W_{Ni}*16.9 + W_{Mn}*18.48 + W_{Co}*18.69 + W_{Fe}*21.879 + W_{In}*29 + W_{Sn}*28.207 + W_{Ga}*42.379 + W_{Ag}*9.0 \geq 130 \quad -1$$

and wherein the following condition 2 is satisfied in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, W_{Mn}, W_{Ru} , W_{Ir} , W_{Rh} , W_{Au} , W_{Pt} , W_{Ag} and W_{Re} are the weight percent of cobalt, copper, iron, gallium, indium, nickel, palladium, tin, manganese, ruthenium, iridium, rhodium, gold, platinum, silver and rhenium in the alloy respectively

$$16.6 < -0.10406*W_{Ag} - 0.1028*W_{Co} - 0.1201*W_{Cu} - 0.2113*W_{Fe} - 0.3368*W_{Ga} - 0.1125*W_{In} - 0.1639*W_{Ni} - 0.015*W_{Pd} - 0.1959*W_{Sn} + 17.276261 - 0.20*W_{Mn} + 0.0678*W_{Ru} + 0.035*W_{Ir} + 0.045*W_{Rh} - 0.059*W_{Au} + 0.066*W_{Re} \leq 17.1 \quad -2$$

and wherein the following equation 3 is satisfied in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, W_{Mn}, W_{Ru}, W_{Ir}, W_{Rh}, W_{Au} , W_{Ag} and W_{Re} are the weight percent of aluminium, cobalt, copper, iron, gallium, indium, nickel, palladium, tin, titanium, manganese, ruthenium, iridium, rhodium, gold, silver and rhenium in the alloy respectively

$$4.22W_{Ag}^2 + 0.041W_{Au}W_{Co} + 0.122W_{Au}W_{In} + 1.96W_{Au}W_{Ni} + 1.87W_{Au}W_{Sn} + 0.903W_{Au}^2 + 1.74W_{Co}W_{Ga} + 13.4W_{Co}W_{In} + 1.24W_{Co}W_{Mn} + 5.04W_{Co}W_{Sn} + 1.02W_{Co}^2 + 8.97W_{Cu}W_{Fe} + 1.74W_{Cu}W_{Ga} + 4.38W_{Cu}W_{In} + 1.16W_{Cu}W_{Mn} + 0.491W_{Cu}W_{Ni} + 3.69W_{Cu}W_{Sn} + 0.22W_{Cu}^2 + 1.68W_{Fe}W_{Ga} + 3.31W_{Fe}W_{In} - 1.26W_{Fe}W_{Mn} + 5.07W_{Fe}W_{Sn} + 0.199W_{Fe}^2 + 5.35W_{Ga}W_{In} + 0.086W_{Ga}W_{Mn} + 3.27W_{Ga}W_{Re} + 33.3W_{Ga}W_{Rh} + 4.56W_{Ga}W_{Ru} + 2.21W_{Ga}W_{Sn} + 29.0W_{Ga} + 8.49W_{Ga}^2$$

$$+ 9.09W_{In}W_{Mn} - 0.28W_{In}W_{Ni} + 15.4W_{In}W_{Rh} + 0.992W_{In}W_{Ru} + 11.7W_{In} + 6.68W_{In}^2 + 0.863W_{Ir}^2 + 5.73W_{Mn}W_{Ni} - 0.02W_{Mn}W_{Ru} + 5.68W_{Mn}W_{Sn} + 18.4W_{Mn} - 0.89W_{Mn}^2 + 0.49W_{Ni}W_{Ru} + 0.186W_{Ni}^2 + 4.48W_{Re}W_{Sn} + 1.15W_{Re}^2 - 5.11W_{Rh}W_{Sn} + 2.04W_{Rh}^2 + 0.885W_{Ru}W_{Sn} + 1.28W_{Ru}^2 + 1.58W_{Sn} + 9.49W_{Sn}^2 + 11.6 \leq 100 \quad - 3.$$

The present disclosure provides a platinum alloy composition consisting, in weight percent, of: 0.0 to 5.0 gold, 0.0 to 2.5 cobalt, 0.0 to 3.0 copper, 0.0 to 5.0 iron, 0.0 to 2.75 gallium, 0.0 to 3.0 indium, 0.0 to 5.0 iridium, 0.0 to 5.0 manganese, 0.0 to 5.0 palladium, 0.0 to 5.0 rhenium, 0.0 to 5.0 rhodium, 0.0 to 5.0 ruthenium, 0.0 to 3.0 tin, 0.0 to 5.0 silver, with the sum of platinum and iridium being 95.0 or more and incidental impurities, wherein the following equation is satisfied in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, $W_{Rh,}$ $W_{Ir,}$ W_{Au}, W_{Ru} , W_{Re} , W_{Ag} and W_{Mn} are the weight percent of cobalt, copper, iron, gallium, indium, nickel, palladium, tin, rhodium, iridium, gold, ruthenium, rhenium, silver and manganese in the alloy respectively

$$60 + W_{Pd}*2.5 + W_{Rh}*3.4 + W_{Ir}*6.455 + W_{Au}*11.93 + W_{Ru}*13.241 + W_{Cu}*14.328 + W_{Re}*16.6 + W_{Ni}*16.9 + W_{Mn}*18.48 + W_{Co}*18.69 + W_{Fe}*21.879 + W_{In}*29 + W_{Sn}*28.207 + W_{Ga}*42.379 + W_{Ag}*9.0 \geq 130$$

and wherein the following condition is satisfied in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, W_{Mn}, W_{Ru} , W_{Ir} , W_{Rh} , W_{Au} , W_{Pt} , W_{Ag} and W_{Re} are the weight percent of cobalt, copper, iron, gallium, indium, nickel, palladium, tin, manganese, ruthenium, iridium, rhodium, gold, platinum, silver and rhenium in the alloy respectively

$$16.6 < -0.10406*W_{Ag} - 0.1028*W_{Co} - 0.1201*W_{Cu} - 0.2113*W_{Fe} - 0.3368*W_{Ga} - 0.1125*W_{In} - 0.1639*W_{Ni} - 0.015*W_{Pd} - 0.1959*W_{Sn} + 17.276261 - 0.20*W_{Mn} + 0.0678*W_{Ru} + 0.035*W_{Ir} + 0.045*W_{Rh} - 0.059*W_{Au} + 0.066*W_{Re} \leq 17.1$$

and wherein the following equation is satisfied in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, W_{Mn}, W_{Ru}, W_{Ir}, W_{Rh}, W_{Au} , W_{Ag} and W_{Re} are the weight percent of aluminium, cobalt, copper, iron, gallium, indium, nickel, palladium, tin, titanium, manganese, ruthenium, iridium, rhodium, gold, silver and rhenium in the alloy respectively

$$4.22W_{Ag}^2 + 0.041W_{Au}W_{Co} + 0.122W_{Au}W_{In} + 1.96W_{Au}W_{Ni} + 1.87W_{Au}W_{Sn} + 0.903W_{Au}^2 + 1.74W_{Co}W_{Ga} + 13.4W_{Co}W_{In} + 1.24W_{Co}W_{Mn} + 5.04W_{Co}W_{Sn} + 1.02W_{Co}^2 + 8.97W_{Cu}W_{Fe} + 1.74W_{Cu}W_{Ga} + 4.38W_{Cu}W_{In} + 1.16W_{Cu}W_{Mn} + 0.491W_{Cu}W_{Ni} + 3.69W_{Cu}W_{Sn} + 0.22W_{Cu}^2 + 1.68W_{Fe}W_{Ga} + 3.31W_{Fe}W_{In} - 1.26W_{Fe}W_{Mn} + 5.07W_{Fe}W_{Sn} + 0.199W_{Fe}^2 + 5.35W_{Ga}W_{In} + 0.086W_{Ga}W_{Mn} + 3.27W_{Ga}W_{Re} + 33.3W_{Ga}W_{Rh} + 4.56W_{Ga}W_{Ru} + 2.21W_{Ga}W_{Sn} + 29.0W_{Ga} + 8.49W_{Ga}^2$$

$+ 9.09W_{In}W_{Mn} - 0.28W_{In}W_{Ni} + 15.4W_{In}W_{Rh} + 0.992W_{In}W_{Ru} + 11.7W_{In} + 6.68W_{In}^2 + 0.863W_{Ir}^2 + 5.73W_{Mn}W_{Ni} - 0.02W_{Mn}W_{Ru} + 5.68W_{Mn}W_{Sn} + 18.4W_{Mn} - 0.89W_{Mn}^2 + 0.49W_{Ni}W_{Ru} + 0.186W_{Ni}^2 + 4.48W_{Re}W_{Sn} + 1.15W_{Re}^2 - 5.11W_{Rh}W_{Sn} + 2.04W_{Rh}^2 + 0.885W_{Ru}W_{Sn} + 1.28W_{Ru}^2 + 1.58W_{Sn} + 9.49W_{Sn}^2 + 11.6 \leq 100$

Such an alloy has a good balance between hardness, castability and solderability.

In an example the platinum alloy composition, consists, in weight percent, of 95.0 or more platinum. Such an alloy is accepted around the world as a hallmarking standard for jewellery applications.

In an example the platinum alloy composition satisfies the following equation in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, W_{Rh}, W_{Ir}, W_{Au} , W_{Ru} , W_{Re} , W_{Ag} and W_{Mn} are the weight percent of cobalt, copper, iron, gallium, indium, nickel, palladium, tin, rhodium, iridium, gold, ruthenium, rhenium, silver and manganese in the alloy respectively

$$60 + W_{Pd}*2.5 + W_{Rh}*3.4 + W_{Ir}*6.455 + W_{Au}*11.93 + W_{Ru}*13.241 + W_{Cu}*14.328 + W_{Re}*16.6 + W_{Ni}*16.9 + W_{Mn}*18.48 + W_{Co}*18.69 + W_{Fe}*21.879 + W_{In}*29 + W_{Sn}*28.207 + W_{Ga}*42.379 + W_{Ag}*9.0 \geq 140$$

preferably wherein

$$60 + W_{Pd}*2.5 + W_{Rh}*3.4 + W_{Ir}*6.455 + W_{Au}*11.93 + W_{Ru}*13.241 + W_{Cu}*14.328 + W_{Re}*16.6 + W_{Ni}*16.9 + W_{Mn}*18.48 + W_{Co}*18.69 + W_{Fe}*21.879 + W_{In}*29 + W_{Sn}*28.207 + W_{Ga}*42.379 + W_{Ag}*9.0 \geq 150$$

more preferably wherein

$$60 + W_{Pd}*2.5 + W_{Rh}*3.4 + W_{Ir}*6.455 + W_{Au}*11.93 + W_{Ru}*13.241 + W_{Cu}*14.328 + W_{Re}*16.6 + W_{Ni}*16.9 + W_{Mn}*18.48 + W_{Co}*18.69 + W_{Fe}*21.879 + W_{In}*29 + W_{Sn}*28.207 + W_{Ga}*42.379 + W_{Ag}*9.0 \geq 160$$

yet more preferably wherein

$$60 + W_{Pd}*2.5 + W_{Rh}*3.4 + W_{Ir}*6.455 + W_{Au}*11.93 + W_{Ru}*13.241 + W_{Cu}*14.328 + W_{Re}*16.6 + W_{Ni}*16.9 + W_{Mn}*18.48 + W_{Co}*18.69 + W_{Fe}*21.879 + W_{In}*29 + W_{Sn}*28.207 + W_{Ga}*42.379 + W_{Ag}*9.0 \geq 170$$

Such an alloy has improved hardness useful for certain jewellery applications.

In an example the platinum alloy composition satisfies the following equation in which W_{Ga}, W_{In}, and W_{Sn} are the weight percent of gallium, indium, and tin in the alloy
$W_{Sn}+ W_{In} + W_{Ga} \geq 0.25$, preferably $W_{Sn}+ W_{In} + W_{Ga} \geq 0.40$, more preferably $W_{Sn}+ W_{In} + W_{Ga} \geq 0.50$ and most preferably $W_{Sn}+ W_{In} + W_{Ga} \geq 0.75$. Such an alloy has increased hardness.

In an example the platinum alloy composition, consists, in weight percent, of 2.0 or less iridium. Such an alloy has a lower cost.

In an example the platinum alloy composition, consists, in weight percent, of 2.0 or less rhodium. Such an alloy has a lower cost.

In an example the platinum alloy composition, consists, in weight percent, of 3.0 or less ruthenium, preferably 2.5 or less ruthenium, preferably 2.0 or less ruthenium. Such an alloy has lower cost and reduced melting point.

In an example the platinum alloy composition, consists, in weight percent, of 2.0 or less rhenium. Such an alloy has reduced cost.

In an example the platinum alloy composition, consists, in weight percent, of 2.0 or less indium, preferably 1.7 or less indium. Such an alloy has improved castability and solderability.

In an example the platinum alloy composition, consists, in weight percent, of 2.0 or less tin, preferably 1.5 or less tin, more preferably 1.0 or less tin. Such an alloy has improved castability and solderability.

In an example the platinum alloy composition satisfies the following equation in which W_{Ga}, W_{Sn}, W_{Ag} and W_{Au} are the weight percent of gallium, tin, silver and gold in the alloy respectively

$$0.45W_{Ag} + 0.35W_{Au} + 0.6W_{Sn} + 0.6W_{In} + W_{Ga} \leq 4.0,$$
preferably
$$0.45W_{Ag} + 0.35W_{Au} + 0.6W_{Sn} + 0.6W_{In} + W_{Ga} \leq 3.0$$

Such an alloy has a low solidification range.

In an example the platinum alloy composition, consists, in weight percent, of 3.0 or less gold, preferably 2.0 or less gold, more preferably 0.5 wt% or less gold and most preferably wherein gold is substantially absent. Such an alloy has improved castability and solderability.

In an example the platinum alloy composition, consists, in weight percent, of 2.0 or less copper, preferably 1.0 or less copper. Such an alloy has reduced solidification range.

In an example the platinum alloy composition, consists, in weight percent, of 2.0 or less gallium, preferably 1.5 or less gallium. Such an alloy has reduced solidification range.

In an example the platinum alloy composition, consists, in weight percent, of 0.25 wt% or more total sum weight percent of iridium, rhenium, rhodium, and ruthenium, preferably 0.5 wt% or more total sum weight percent of iridium, rhenium, rhodium, and ruthenium, more preferably 0.75 wt% or more total sum weight percent of iridium, rhenium, rhodium, and ruthenium, more preferably 1.0 wt% or more total sum weight percent of iridium, rhenium, rhodium, and ruthenium, more preferably 1.2 wt% or more total sum weight percent of iridium, rhenium, rhodium, and ruthenium, more preferably 1.4 wt% or more total sum weight percent of iridium, rhenium, rhodium, and ruthenium and most preferably 1.5 wt% or more total sum weight percent of iridium, rhenium, rhodium, and ruthenium. Such an alloy has increased melting point without a substantial increase in solidification range.

In an example the platinum alloy composition satisfies the following equation in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, W_{Mn}, W_{Ru}, W_{Ir}, W_{Rh}, W_{Au} , W_{Ag} and W_{Re} are the weight percent of aluminium, cobalt, copper, iron, gallium, indium, nickel, palladium, tin, titanium, manganese, ruthenium, iridium, rhodium, gold, silver and rhenium in the alloy respectively

$$4.22W_{Ag}^2 + 0.041W_{Au}W_{Co} + 0.122W_{Au}W_{In} + 1.96W_{Au}W_{Ni} + 1.87W_{Au}W_{Sn} + 0.903W_{Au}^2 + 1.74W_{Co}W_{Ga} + 13.4W_{Co}W_{In} + 1.24W_{Co}W_{Mn} + 5.04W_{Co}W_{Sn} + 1.02W_{Co}^2 + 8.97W_{Cu}W_{Fe} + 1.74W_{Cu}W_{Ga} + 4.38W_{Cu}W_{In} + 1.16W_{Cu}W_{Mn} + 0.491W_{Cu}W_{Ni} + 3.69W_{Cu}W_{Sn} + 0.22W_{Cu}^2 + 1.68W_{Fe}W_{Ga} + 3.31W_{Fe}W_{In} - 1.26W_{Fe}W_{Mn} + 5.07W_{Fe}W_{Sn} + 0.199W_{Fe}^2 + 5.35W_{Ga}W_{In} + 0.086W_{Ga}W_{Mn} + 3.27W_{Ga}W_{Re} + 33.3W_{Ga}W_{Rh} + 4.56W_{Ga}W_{Ru} + 2.21W_{Ga}W_{Sn} + 29.0W_{Ga} + 8.49W_{Ga}^2 + 9.09W_{In}W_{Mn} - 0.28W_{In}W_{Ni} + 15.4W_{In}W_{Rh} + 0.992W_{In}W_{Ru} + 11.7W_{In} + 6.68W_{In}^2 + 0.863W_{Ir}^2 + 5.73W_{Mn}W_{Ni} - 0.02W_{Mn}W_{Ru} + 5.68W_{Mn}W_{Sn} + 18.4W_{Mn} - 0.89W_{Mn}^2 + 0.49W_{Ni}W_{Ru} + 0.186W_{Ni}^2 +$$

$4.48W_{Re}W_{Sn} + 1.15W_{Re}^2 - 5.11W_{Rh}W_{Sn} + 2.04W_{Rh}^2 + 0.885W_{Ru}W_{Sn} + 1.28W_{Ru}^2 + 1.58W_{Sn} + 9.49W_{Sn}^2 + 11.6 \leq 90$

preferably

$4.22W_{Ag}^2 + 0.041W_{Au}W_{Co} + 0.122W_{Au}W_{In} + 1.96W_{Au}W_{Ni} + 1.87W_{Au}W_{Sn} + 0.903W_{Au}^2 + 1.74W_{Co}W_{Ga} + 13.4W_{Co}W_{In} + 1.24W_{Co}W_{Mn} + 5.04W_{Co}W_{Sn} + 1.02W_{Co}^2 + 8.97W_{Cu}W_{Fe} + 1.74W_{Cu}W_{Ga} + 4.38W_{Cu}W_{In} + 1.16W_{Cu}W_{Mn} + 0.491W_{Cu}W_{Ni} + 3.69W_{Cu}W_{Sn} + 0.22W_{Cu}^2 + 1.68W_{Fe}W_{Ga} + 3.31W_{Fe}W_{In} - 1.26W_{Fe}W_{Mn} + 5.07W_{Fe}W_{Sn} + 0.199W_{Fe}^2 + 5.35W_{Ga}W_{In} + 0.086W_{Ga}W_{Mn} + 3.27W_{Ga}W_{Re} + 33.3W_{Ga}W_{Rh} + 4.56W_{Ga}W_{Ru} + 2.21W_{Ga}W_{Sn} + 29.0W_{Ga} + 8.49W_{Ga}^2 + 9.09W_{In}W_{Mn} - 0.28W_{In}W_{Ni} + 15.4W_{In}W_{Rh} + 0.992W_{In}W_{Ru} + 11.7W_{In} + 6.68W_{In}^2 + 0.863W_{Ir}^2 + 5.73W_{Mn}W_{Ni} - 0.02W_{Mn}W_{Ru} + 5.68W_{Mn}W_{Sn} + 18.4W_{Mn} - 0.89W_{Mn}^2 + 0.49W_{Ni}W_{Ru} + 0.186W_{Ni}^2 + 4.48W_{Re}W_{Sn} + 1.15W_{Re}^2 - 5.11W_{Rh}W_{Sn} + 2.04W_{Rh}^2 + 0.885W_{Ru}W_{Sn} + 1.28W_{Ru}^2 + 1.58W_{Sn} + 9.49W_{Sn}^2 + 11.6 \leq 85$

more preferably

$4.22W_{Ag}^2 + 0.041W_{Au}W_{Co} + 0.122W_{Au}W_{In} + 1.96W_{Au}W_{Ni} + 1.87W_{Au}W_{Sn} + 0.903W_{Au}^2 + 1.74W_{Co}W_{Ga} + 13.4W_{Co}W_{In} + 1.24W_{Co}W_{Mn} + 5.04W_{Co}W_{Sn} + 1.02W_{Co}^2 + 8.97W_{Cu}W_{Fe} + 1.74W_{Cu}W_{Ga} + 4.38W_{Cu}W_{In} + 1.16W_{Cu}W_{Mn} + 0.491W_{Cu}W_{Ni} + 3.69W_{Cu}W_{Sn} + 0.22W_{Cu}^2 + 1.68W_{Fe}W_{Ga} + 3.31W_{Fe}W_{In} - 1.26W_{Fe}W_{Mn} + 5.07W_{Fe}W_{Sn} + 0.199W_{Fe}^2 + 5.35W_{Ga}W_{In} + 0.086W_{Ga}W_{Mn} + 3.27W_{Ga}W_{Re} + 33.3W_{Ga}W_{Rh} + 4.56W_{Ga}W_{Ru} + 2.21W_{Ga}W_{Sn} + 29.0W_{Ga} + 8.49W_{Ga}^2 + 9.09W_{In}W_{Mn} - 0.28W_{In}W_{Ni} + 15.4W_{In}W_{Rh} + 0.992W_{In}W_{Ru} + 11.7W_{In} + 6.68W_{In}^2 + 0.863W_{Ir}^2 + 5.73W_{Mn}W_{Ni} - 0.02W_{Mn}W_{Ru} + 5.68W_{Mn}W_{Sn} + 18.4W_{Mn} - 0.89W_{Mn}^2 + 0.49W_{Ni}W_{Ru} + 0.186W_{Ni}^2 + 4.48W_{Re}W_{Sn} + 1.15W_{Re}^2 - 5.11W_{Rh}W_{Sn} + 2.04W_{Rh}^2 + 0.885W_{Ru}W_{Sn} + 1.28W_{Ru}^2 + 1.58W_{Sn} + 9.49W_{Sn}^2 + 11.6 \leq 80$

even more preferably

$4.22W_{Ag}^2 + 0.041W_{Au}W_{Co} + 0.122W_{Au}W_{In} + 1.96W_{Au}W_{Ni} + 1.87W_{Au}W_{Sn} + 0.903W_{Au}^2 + 1.74W_{Co}W_{Ga} + 13.4W_{Co}W_{In} + 1.24W_{Co}W_{Mn} + 5.04W_{Co}W_{Sn} + 1.02W_{Co}^2 + 8.97W_{Cu}W_{Fe} + 1.74W_{Cu}W_{Ga} + 4.38W_{Cu}W_{In} + 1.16W_{Cu}W_{Mn} + 0.491W_{Cu}W_{Ni} + 3.69W_{Cu}W_{Sn} + 0.22W_{Cu}^2 + 1.68W_{Fe}W_{Ga} + 3.31W_{Fe}W_{In} - 1.26W_{Fe}W_{Mn} + 5.07W_{Fe}W_{Sn} + 0.199W_{Fe}^2 + 5.35W_{Ga}W_{In} + 0.086W_{Ga}W_{Mn} + 3.27W_{Ga}W_{Re} + 33.3W_{Ga}W_{Rh} + 4.56W_{Ga}W_{Ru} + 2.21W_{Ga}W_{Sn} + 29.0W_{Ga} + 8.49W_{Ga}^2 + 9.09W_{In}W_{Mn} - 0.28W_{In}W_{Ni} + 15.4W_{In}W_{Rh} + 0.992W_{In}W_{Ru} + 11.7W_{In} + 6.68W_{In}^2 + 0.863W_{Ir}^2 + 5.73W_{Mn}W_{Ni} - 0.02W_{Mn}W_{Ru} + 5.68W_{Mn}W_{Sn} + 18.4W_{Mn} - 0.89W_{Mn}^2 + 0.49W_{Ni}W_{Ru} + 0.186W_{Ni}^2 + 4.48W_{Re}W_{Sn} + 1.15W_{Re}^2 - 5.11W_{Rh}W_{Sn} + 2.04W_{Rh}^2 + 0.885W_{Ru}W_{Sn} + 1.28W_{Ru}^2 + 1.58W_{Sn} + 9.49W_{Sn}^2 + 11.6 \leq 75$

most preferably

$4.22W_{Ag}^2 + 0.041W_{Au}W_{Co} + 0.122W_{Au}W_{In} + 1.96W_{Au}W_{Ni} + 1.87W_{Au}W_{Sn} + 0.903W_{Au}^2 + 1.74W_{Co}W_{Ga} + 13.4W_{Co}W_{In} + 1.24W_{Co}W_{Mn} + 5.04W_{Co}W_{Sn} + 1.02W_{Co}^2 + 8.97W_{Cu}W_{Fe} + 1.74W_{Cu}W_{Ga} + 4.38W_{Cu}W_{In} + 1.16W_{Cu}W_{Mn} + 0.491W_{Cu}W_{Ni} + 3.69W_{Cu}W_{Sn} + 0.22W_{Cu}^2 + 1.68W_{Fe}W_{Ga} + 3.31W_{Fe}W_{In} - 1.26W_{Fe}W_{Mn} + 5.07W_{Fe}W_{Sn} + 0.199W_{Fe}^2 + 5.35W_{Ga}W_{In} + 0.086W_{Ga}W_{Mn} + 3.27W_{Ga}W_{Re} + 33.3W_{Ga}W_{Rh} + 4.56W_{Ga}W_{Ru} + 2.21W_{Ga}W_{Sn} + 29.0W_{Ga} + 8.49W_{Ga}^2 + 9.09W_{In}W_{Mn} - 0.28W_{In}W_{Ni} + 15.4W_{In}W_{Rh} + 0.992W_{In}W_{Ru} + 11.7W_{In} + 6.68W_{In}^2 + 0.863W_{Ir}^2 + 5.73W_{Mn}W_{Ni} - 0.02W_{Mn}W_{Ru} + 5.68W_{Mn}W_{Sn} + 18.4W_{Mn} - 0.89W_{Mn}^2 + 0.49W_{Ni}W_{Ru} + 0.186W_{Ni}^2 + 4.48W_{Re}W_{Sn} + 1.15W_{Re}^2 - 5.11W_{Rh}W_{Sn} + 2.04W_{Rh}^2 + 0.885W_{Ru}W_{Sn} + 1.28W_{Ru}^2 + 1.58W_{Sn} + 9.49W_{Sn}^2 + 11.6 \leq 70$

Such an alloy has reduced solidification range and so improved castability and solderability.

In an example the platinum alloy composition satisfies the following equation in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ni}, and W_{Pd} are the weight percent of cobalt, copper, iron, nickel and palladium in the alloy

$W_{Co}+ W_{Pd} + W_{Fe}+ W_{Ni} + W_{Cu} \geq 1.0$
preferably
$W_{Co}+ W_{Pd} + W_{Fe}+ W_{Ni} + W_{Cu} \geq 2.0$.

Such an alloy has a lower melting point without a dramatic increase in solidification range.

In an example the platinum alloy comprises at least one element from the list of cobalt, palladium, iron and copper, preferably wherein the sum of cobalt, palladium, iron and copper is 1.0 wt% or more, more preferably 1.1 wt.% or more. Such an alloy achieves a superior balance of castability, solderability and hardness.

In an example the platinum alloy composition comprises at least one element from the list of ruthenium, rhenium, iridium and rhodium, preferably wherein the sum of ruthenium, rhenium, iridium and rhodium is 0.25 wt% or more, preferably 0.5 wt% or more, more preferably 0.75 wt% or more, more preferably 1.0 wt% or more, more preferably 1.2 wt% or more and most preferably 1.4 or more. Such an alloy achieves a superior balance of castability, solderability and hardness.

In an example the platinum alloy composition comprises at least one element from the list of tin, indium and gallium, preferably wherein the sum of tin, indium and gallium is 1.2 wt% or more, more preferably 1.6 or more. Such an alloy achieves a superior balance of castability, solderability and hardness.

In an example the platinum alloy composition satisfies the following equation in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, W_{Mn}, W_{Ru} , W_{Ir} , W_{Rh} , W_{Au} , W_{Pt} , W_{Ag} and W_{Re} are the weight percent of cobalt, copper, iron, gallium, indium, nickel, palladium, tin, manganese, ruthenium, iridium, rhodium, gold, platinum, silver and rhenium in the alloy respectively

$16.65 \leq -0.10406*W_{Ag} - 0.1028*W_{Co} - 0.1201*W_{Cu} - 0.2113*W_{Fe} - 0.3368*W_{Ga} - 0.1125*W_{In} - 0.1639*W_{Ni} - 0.015*W_{Pd} - 0.1959*W_{Sn} + 17.276261 - 0.20*W_{Mn} + 0.0678*W_{Ru} + 0.035*W_{Ir} + 0.045*W_{Rh} - 0.059*W_{Au} + 0.066*W_{Re}$
preferably
$16.70 \leq -0.10406*W_{Ag} - 0.1028*W_{Co} - 0.1201*W_{Cu} - 0.2113*W_{Fe} - 0.3368*W_{Ga} - 0.1125*W_{In} - 0.1639*W_{Ni} - 0.015*W_{Pd} - 0.1959*W_{Sn} + 17.276261 - 0.20*W_{Mn} + 0.0678*W_{Ru} + 0.035*W_{Ir} + 0.045*W_{Rh} - 0.059*W_{Au} + 0.066*W_{Re}$

Such an alloy has further improved solderability whilst remaining castable.

In an example the platinum alloy composition satisfies the following equation in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, W_{Mn}, W_{Ru} , W_{Ir} , W_{Rh} , W_{Au} , W_{Pt} , W_{Ag} and W_{Re} are the weight percent of cobalt, copper, iron, gallium, indium, nickel, palladium, tin, manganese, ruthenium, iridium, rhodium, gold, platinum, silver and rhenium in the alloy respectively

$-0.10406*W_{Ag} - 0.1028*W_{Co} - 0.1201*W_{Cu} - 0.2113*W_{Fe} - 0.3368*W_{Ga} - 0.1125*W_{In} - 0.1639*W_{Ni} - 0.015*W_{Pd} - 0.1959*W_{Sn} + 17.276261 - 0.20*W_{Mn} + 0.0678*W_{Ru} + 0.035*W_{Ir} + 0.045*W_{Rh} - 0.059*W_{Au} + 0.066*W_{Re} \leq 17.00$

Such an alloy has improved castability.

In an example the platinum alloy composition consists of platinum, indium, ruthenium, tin and iron. Such an alloy achieves a superior balance of castability, solderability and hardness.

In an example the platinum alloy composition consists of platinum, ruthenium, iron and gallium. Such an alloy achieves a superior balance of castability, solderability and hardness.

In an example the platinum alloy composition includes, in weight percent, 0.5 to 2.0 indium. Such an alloy has a lower melting point and increased hardness without a large increase in solidification range.

In an example the platinum alloy composition includes, in weight percent, 1.0 to 2.5 ruthenium. Such an alloy has increased hardness without an excessive increase in cost.

In an example the platinum alloy composition includes, in weight percent, 0.2 to 1.0 tin. Such an alloy has a lower melting point and increased hardness without a large increase in solidification range.

In an example the platinum alloy composition includes, in weight percent, 0.5 to 1.75 iron. Such an alloy has a lower melting point and increased hardness at low cost, with low risk of ferromagnetism.

In an example the platinum alloy composition includes, in weight percent, 0.5 to 1.75 gallium. Such an alloy has a lower melting point and increased hardness without a large increase in solidification range.

In an example the platinum alloy composition includes, in weight percent, 4.0 or less iron, preferably 2.5 wt% or less iron, more preferably 2.25 wt% or less iron, more preferably 2.0 wt% or less iron, more preferably 1.75 or less iron, more preferably 1.75 or less iron. Such an alloy has low risk of ferromagnetism.

In an example the platinum alloy composition includes, in weight percent, 2.0 or less cobalt, preferably 1.0 or less cobalt, more preferably substantially no cobalt. Such an alloy has lower risk of ferromagnetism and lower allergy concerns.

In an example the platinum alloy composition includes, in weight percent, 3.0 or less palladium, preferably 2.5 or less palladium, more preferably 2.0 or less palladium, more preferably 1.5 or less palladium, more preferably 0.1 or less palladium, most preferably substantially no palladium. Such an alloy has lower cost.

In an example the platinum alloy composition includes, in weight percent, 3.0 or less manganese, preferably 2.5 or less manganese, more preferably 0.1 or less manganese, most preferably substantially no manganese. Such an alloy has lower risk of volatilisation.

In an example the platinum alloy composition includes, in weight percent, 0.5 or more indium, preferably 0.75 or more indium, more preferably 1.0 or more indium. Such an alloy has improved hardness.

In an example the platinum alloy composition includes, in weight percent, 0.5 or more ruthenium, preferably 0.8 or more ruthenium, more preferably 1.0 or more ruthenium, more preferably 1.2 or more ruthenium. Such an alloy has higher hardness at lower cost.

In an example the platinum alloy composition includes, in weight percent, 0.2 or more tin. Such an alloy has improved hardness.

In an example the platinum alloy composition includes, in weight percent, 0.25 or more iron, preferably 0.5 or more iron, more preferably 0.75 or more iron, more preferably 1.0 or more iron. Such an alloy has improved hardness without a significant increase in solidification range.

In an example the platinum alloy composition includes, in weight percent, 0.5 or more gallium, preferably 0.75 or more gallium, more preferably 1.0 or more gallium. Such an alloy has reduced melting point and increased hardness.

In an example the platinum alloy composition has a sum of cobalt, palladium, iron and copper of 1.5 wt% or less. Such an alloy has increased hardness.

In an example the platinum alloy composition has a sum of ruthenium, rhenium, iridium and rhodium of 2.7 wt% or less, more preferably 2.6wt% or less. Such an alloy has reduced solidification range.

In an example the platinum alloy composition has a sum of tin, indium and gallium of 2.7 wt% or less, more preferably 2.5 wt% or less. Such an alloy has improved castabilty and solderability.

In an example the platinum alloy composition consists, in weight percent, of: 1.2±0.2 iron, 1.5±0.2 indium, 1.5±0.2 ruthenium, 0.6 tin with the remainder (optionally at least 95%) being platinum and incidental impurities. Such an alloy has been show to exhibit good castability, solderability and hardness.

In an example the platinum alloy composition consists, in weight percent, of: 1.2±0.2 iron, 1.2±0.2 gallium, 2.4±0.2 ruthenium with the remainder (optionally at least 95%) being platinum and incidental impurities. Such an alloy has been show to exhibit good castability, solderability and hardness.

In an example the platinum alloy composition consists, in weight percent, of: 1.2±0.2 iron, 1.5±0.2 indium, 1.5±0.2 ruthenium, 0.6 tin with the remainder (optionally at least 95%) being platinum and incidental impurities. Such an alloy has been show to exhibit good castability, solderability and hardness.

In another aspect, there is provided jewellery comprising a platinum alloy composition as defined above.

The term “consisting of” is used herein to indicate that 100% of the composition is being referred to and the presence of additional components is excluded so that percentages add up to 100%.

The invention will be more fully described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows the porosity measured on cast samples of some Examples of the invention and Comparative examples.

Figure 2 illustrates defects in casting of Comparative examples in contrast to no defects in Examples of the invention.

Figure 3 illustrates solderability of comparative examples and examples of the invention.

Figure 4 shows a silica inclusion present on the fracture surface of Comparative Example 14. The presence of silica indicates the alloy has poor castability.

Figure 5 compares trees of an example of the invention to a comparative example, of identical geometry and cast under the same conditions. The example of the invention shows excellent form filling ability, unlike the comparative example.

Claims

1. A platinum alloy composition consisting, in weight percent, of: 0.0 to 5.0 gold, 0.0 to 2.5 cobalt, 0.0 to 3.0 copper, 0.25 to 2.5 iron, 0.0 to 2.75 gallium, 0.0 to 3.0 indium, 0.0 to 5.0 iridium, 0.0 to 5.0 manganese, 0.0 to 5.0 palladium, 0.0 to 5.0 rhenium, 0.0 to 5.0 rhodium, 0.0 to 5.0 ruthenium, 0.0 to 3.0 tin, 0.0 to 5.0 silver, with the sum of platinum and iridium being 95.0 or more and 1.0 wt.% or less of incidental impurities, wherein the following equation 1 is satisfied in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, W_{Rh}, W_{Ir}, W_{Au}, W_{Ru} , W_{Re} , W_{Ag} and W_{Mn} are the weight percent of cobalt, copper, iron, gallium, indium, nickel, palladium, tin, rhodium, iridium, gold, ruthenium, rhenium, silver and manganese in the alloy respectively

$$60 + W_{Pd}*2.5 + W_{Rh}*3.4 + W_{Ir}*6.455 + W_{Au}*11.93 + W_{Ru}*13.241 + W_{Cu}*14.328 + W_{Re}*16.6 + W_{Ni}*16.9 + W_{Mn}*18.48 + W_{Co}*18.69 + W_{Fe}*21.879 + W_{In}*29 + W_{Sn}*28.207 + W_{Ga}*42.379 + W_{Ag}*9.0 \geq 130 \quad - 1$$

and wherein the following condition 2 is satisfied in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, W_{Mn}, W_{Ru} , W_{Ir} , W_{Rh} , W_{Au} , W_{Pt} , W_{Ag} and W_{Re} are the weight percent of cobalt, copper, iron, gallium, indium, nickel, palladium, tin, manganese, ruthenium, iridium, rhodium, gold, platinum, silver and rhenium in the alloy respectively

$$16.6 < -0.10406*W_{Ag} - 0.1028*W_{Co} - 0.1201*W_{Cu} - 0.2113*W_{Fe} - 0.3368*W_{Ga} - 0.1125*W_{In} - 0.1639*W_{Ni} - 0.015*W_{Pd} - 0.1959*W_{Sn} + 17.276261 - 0.20*W_{Mn} + 0.0678*W_{Ru} + 0.035*W_{Ir} + 0.045*W_{Rh} - 0.059*W_{Au} + 0.066*W_{Re} \leq 17.1 \quad - 2$$

and wherein the following equation 3 is satisfied in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, W_{Mn}, W_{Ru}, W_{Ir}, W_{Rh}, W_{Au} , W_{Ag} and W_{Re} are the weight percent of aluminium, cobalt, copper, iron, gallium, indium, nickel, palladium, tin, titanium, manganese, ruthenium, iridium, rhodium, gold, silver and rhenium in the alloy respectively

$$4.22W_{Ag}^2 + 0.041W_{Au}W_{Co} + 0.122W_{Au}W_{In} + 1.96W_{Au}W_{Ni} + 1.87W_{Au}W_{Sn} + 0.903W_{Au}^2 + 1.74W_{Co}W_{Ga} + 13.4W_{Co}W_{In} + 1.24W_{Co}W_{Mn} + 5.04W_{Co}W_{Sn} + 1.02W_{Co}^2 + 8.97W_{Cu}W_{Fe} + 1.74W_{Cu}W_{Ga} + 4.38W_{Cu}W_{In} + 1.16W_{Cu}W_{Mn} + 0.491W_{Cu}W_{Ni} + 3.69W_{Cu}W_{Sn} + 0.22W_{Cu}^2 + 1.68W_{Fe}W_{Ga} + 3.31W_{Fe}W_{In} - 1.26W_{Fe}W_{Mn} + 5.07W_{Fe}W_{Sn} + 0.199W_{Fe}^2 + 5.35W_{Ga}W_{In} + 0.086W_{Ga}W_{Mn} + 3.27W_{Ga}W_{Re} + 33.3W_{Ga}W_{Rh} + 4.56W_{Ga}W_{Ru} + 2.21W_{Ga}W_{Sn} + 29.0W_{Ga} + 8.49W_{Ga}^2 + 9.09W_{In}W_{Mn} - 0.28W_{In}W_{Ni} + 15.4W_{In}W_{Rh} + 0.992W_{In}W_{Ru} + 11.7W_{In} + 6.68W_{In}^2 + 0.863W_{Ir}^2 + 5.73W_{Mn}W_{Ni} - 0.02W_{Mn}W_{Ru} + 5.68W_{Mn}W_{Sn} + 18.4W_{Mn} - 0.89W_{Mn}^2 + 0.49W_{Ni}W_{Ru} + 0.186W_{Ni}^2 + 4.48W_{Re}W_{Sn} + 1.15W_{Re}^2 - 5.11W_{Rh}W_{Sn} + 2.04W_{Rh}^2 + 0.885W_{Ru}W_{Sn} + 1.28W_{Ru}^2 + 1.58W_{Sn} + 9.49W_{Sn}^2 + 11.6 \leq 100 \quad - 3.$$

2. The platinum alloy composition of claim 1, wherein the equation 1 satisfies ≥ 140, preferably ≥ 150, more preferably ≥ 160 and more preferably ≥ 170.

3. The platinum alloy composition of any preceding claim, wherein the equation 3 satisfies ≤ 90, preferably ≤ 85, more preferably ≤ 80, even more preferably ≤ 75, most preferably ≤ 70.

4. The platinum alloy composition of any preceding claim, wherein the following equation is satisfied in which W_{Co}, W_{Cu}, W_{Fe}, W_{Ga}, W_{In}, W_{Ni}, W_{Pd}, W_{Sn}, W_{Mn}, W_{Ru} , W_{Ir} , W_{Rh} , W_{Au} , W_{Pt} , W_{Ag} and W_{Re} are the weight percent of cobalt, copper, iron, gallium, indium, nickel,

palladium, tin, manganese, ruthenium, iridium, rhodium, gold, platinum, silver and rhenium in the alloy respectively

$$-0.10406*W_{Ag} - 0.1028*W_{Co} - 0.1201*W_{Cu} - 0.2113*W_{Fe} - 0.3368*W_{Ga} - 0.1125*W_{In} - 0.1639*W_{Ni} - 0.015*W_{Pd} - 0.1959*W_{Sn} + 17.276261 - 0.20*W_{Mn} + 0.0678*W_{Ru} + 0.035*W_{Ir} + 0.045*W_{Rh} - 0.059*W_{Au} + 0.066*W_{Re} \leq 17.00$$

5. The platinum alloy composition of any preceding claim, wherein the alloy includes, in weight percent, 0.5 or more ruthenium, preferably 0.8 or more ruthenium, more preferably 1.0 or more ruthenium, more preferably 1.2 or more ruthenium.

6. The platinum alloy composition of any preceding claim, wherein the alloy includes, in weight percent, 0.2 or more tin.

7. The platinum alloy composition of any preceding claim, wherein the alloy includes, in weight percent, 0.5 or more indium, preferably 0.75 or more indium, more preferably 1.0 or more indium.

8. The platinum alloy composition of any of claims 1-7, wherein the alloy consists of platinum, indium, ruthenium, tin and iron.

9. The platinum alloy composition of any of claims 1 to 5, wherein the alloy consists of platinum, ruthenium, iron and gallium.

10. The platinum alloy composition of any of claims 1-7 or 9, wherein the alloy includes, in weight percent, 0.5 or more gallium, preferably 0.75 or more gallium, more preferably 1.0 or more gallium.

11. The platinum alloy composition of any preceding claim, wherein the sum of ruthenium, rhenium, iridium and rhodium is 2.7 wt% or less, more preferably 2.6 wt% or less.

12. The platinum alloy composition of claim 1 consisting, in weight percent, of: 1.2±0.2 iron, 1.5±0.2 indium, 1.5±0.2 ruthenium, 0.6 tin with the remainder being platinum and incidental impurities.

13. The platinum alloy composition of claim 1 consisting, in weight percent, of: 1.2±0.2 iron, 1.2±0.2 gallium, 2.4±0.2 ruthenium with the remainder being platinum and incidental impurities.

14. The platinum alloy composition of claim 1 consisting, in weight percent, of: 1.2±0.2 iron, 1.5±0.2 indium, 1.7±0.2 ruthenium, 0.3 tin with the remainder being platinum and incidental impurities.

15. Jewellery comprising a platinum alloy composition of any of claims 1 to 14.