Claims

1. An aqueous electroplating solution for alkaline electroplating, comprising:

[Pt~~M~~$(NH_3)_4]^{2+}$ ions~~, wherein M is selected from the group consisting of Pd or Pt~~; and organic anions selected from the group consisting of bicarbonate, carbonate, or a mixture thereof;

wherein the molar ratio of Pt : (bicarbonate + carbonate) is from 1 : 1 to 1 : 10; and

wherein the following species, if present, are present in the following amounts: alkali metals in an amount of less than 5 g/L;

compounds comprising phosphorus in an amount of less than 5 g/L;

compounds comprising boron in an amount of less than 5 g/L.

~~2. An aqueous electroplating solution according to claim 1, wherein the molar ratio of M : (bicarbonate + carbonate) is from 1 : 1 to 1 : 10.~~

2~~3~~. An aqueous electroplating solution according to claim 1, wherein the molar ratio of Pt~~M~~ : (bicarbonate + carbonate) is from 1 : 1 to 1 : 5.

3~~4~~. An aqueous electroplating solution according to claim 1, wherein the molar ratio of Pt~~M~~ : (bicarbonate + carbonate) is approximately 1 : 2.

4~~5~~. An aqueous electroplating solution according to claim 1, wherein the molar ratio of Pt~~M~~ : (bicarbonate + carbonate) is approximately 1 : 1.

~~6. An aqueous electroplating solution according to any of claims 1 to 5, wherein M is Pt.~~

5~~7~~. An aqueous electroplating solution according to any one of claims 1 to 4~~6~~, wherein the concentration of Pt~~M~~ in the solution is 1 to 30 g/litre, on a metal basis.

6~~8~~. An aqueous electroplating solution according to any one of claims 1 to 5~~7~~, wherein the pH of the solution is 8 to 14.

7~~9~~. An aqueous electroplating solution according to any one of claims 1 to 6~~8~~, comprising a pH adjusting agent selected from the group consisting of ammonia, urea, an alkylammonium hydroxide, ammonium hydroxide, ammonium bicarbonate and ammonium carbonate.

8~~10~~. An aqueous electroplating solution according to any one of claims 1 to 7~~9~~, wherein the content of alkali metals is less than 0.1 g/L.

9~~11~~. An aqueous electroplating solution according to any one of claims 1 to 8~~10~~, wherein the content of halide ions in the electroplating solution is less than 1 g/L.

10~~2~~. An aqueous electroplating solution according to any one of claims 1 to 9~~11~~, wherein the content of nitrite ions in the electroplating solution is less than 0.5 g/L.

11~~3~~. An aqueous electroplating solution according to any one of claims 1 to 10~~2~~, wherein the content of nitrate ions in the electroplating solution is less than 0.5 g/L.

12~~4~~. An aqueous electroplating solution according to any one of claims 1 to 11~~3~~, wherein the content of compounds containing silicon is less than 0.5 g/L.

13~~5~~. An aqueous electroplating solution according to any one of claims 1 to 12~~4~~, wherein the content of compounds containing sulfur is less than 0.5 g/L.

14~~6~~. An electroplating bath comprising a cathode and an anode which are both at least partially submerged in an electrolyte, wherein the electrolyte is an aqueous electroplating solution according to any of claims 1 to 13~~5~~.

15~~7~~. A method of forming a metal layer on a substrate by electroplating, wherein electroplating is carried out using a bath comprising a cathode and an anode which are both at least partially submerged in an electrolyte, wherein the electrolyte is an aqueous electroplating solution according to any of claims 1 to 13~~5~~.

16~~8~~. A method as claimed in claim 15~~7~~, wherein electroplating is carried out at a temperature of 80 °C or more.

17~~9~~. A method as claimed in claim 15~~7~~, wherein electroplating is carried out at a temperature of 60 to 100 °C or more and a pH of 8 to 14.

18~~20~~. A method as claimed in any of claims 15~~7~~ to 17~~9~~, wherein the bath is replenished with fresh electroplating solution as required.

19~~21~~. A method as claimed in any of claims 15~~7~~ to 18~~20~~, wherein a pH adjusting agent is added to the bath as required.

202. A method as claimed in any of claims 157 to 19221, wherein the cathode provides the substrate to be coated.

213. A method as claimed in any of claims 157 to 202, comprising a step of pausing electroplating and increasing the temperature of the electrolyte in order to purge the bath of residual organic anion.

224. A method as claimed in any of claims 15217 to 213, wherein the cathode acts as the substrate and is selected from jewellery, a medical component or an aviation component.