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GOLD ALLOY PLATING

Silvio C. Taormina, Flushing, N. Y., Alfred T. Marinaro, Newark, N. J., and Louis Packman, Brooklyn, N. Y., assignors to Platers Research Corporation, New York, N. Y., a corporation of New York

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This invention relates to gold plating by electro-deposition and is more particularly concerned with the depositions of gold and other metals from the same plating bath to obtain a plate having improved characteristics.

The type of plating is that which is adapted for use in decorative gold plating such as the jewelry and related trades wherein the thickness of the plate may vary from a flash coloring obtained by as little as several seconds of electroplating to a plate having a thickness of 0.005 of an inch.

An important object of this invention is to achieve a gold plate which is extremely resistant to abrasion.

Another object is to provide a more economical gold plate by virtue of the saving of gold effected by reducing the thickness of plate necessary to yield a gold plate having a given period of service.

Another object is to provide a gold plate having certain improved coloration.

A still further object is to provide a type of gold plating solution which will yield a gold plate having a relatively constant and stable coloration.

The invention consists of improving the characteristics of a gold plate as applied by electrodeposition by the addition of soluble compounds of uranium or soluble compounds of molybdenum to an aqueous gold plating solution. It has been determined by spectrographic analysis that the metal coating electrodeposition from the solution, at the cathode, consists of gold together with the metallic elements of said soluble compounds and that such gold plates are considerably more wear and abrasive resistant than gold plates which do not contain the uranium or the molybdenum but which were deposited under similar conditions.

In the practice of this invention, the salts of either uranium, molybdenum, or both are added to an aqueous gold plate bath, such as a cyanide bath. Electroplating is thereafter carried forward in the usual manner. By varying the amounts of the soluble compounds of uranium and molybdenum which are added to the bath, the amounts of those metals in the final plate may be varied and the resulting color of the plate may also be varied. Increasing the uranium content in the gold plate changes the color of the gold from yellow to light yellow, pink, white Hamilton, light purple and finally to a dark purple which is almost black. The darker hues of the gold plates are obtained from solutions having high proportionate uranium content and by increasing the temperature of the solution and also by increasing the current density. When molybdenum is present in the gold plate, the plate will have a light colored gold hue similar to that known in the trade as "Hamilton" gold, i. e. a light gold, between white and yellow. The hue achieved with molybdenum is stable and does not vary appreciably as the amounts of the molybdenum compound present in the plating solution are changed. The use of the soluble molybdenum compound in commercial gold plating solutions is therefore particularly

advantageous where it is desirable to produce a gold plate of constant hue.

The following gold plating baths are set down as examples of typical applications of the practice of this invention; the term "free potassium cyanide" used in the examples may be defined as the alkali cyanide that is not combined in complexes:

Solution I

	Spectrographic Analysis of Plate .0003 of inch thick
Water: Fine Gold, 4 Grams per liter Potassium Molybdate, 4 Grams per liter Free Potassium Cyanide, 15 Grams per liter. Potassium Hydroxide, 7½ Grams per liter.	Gold, major constituent, over 90%. Molybdenum .005–.05%.

Solution II

	Spectrographic Analysis of Plate .0003 of inch thick
Water: Fine Gold, 4 Grams per liter Uranyl Nitrate, 15 Grams per liter Potassium Carbonate, 30 Grams per liter. Free Potassium Cyanide, 4 Grams per liter.	Gold, over 90%. Uranium .05–10%.

Solution III

	Spectrographic Analysis of Plate .0003 of inch thick
Water: Fine Gold, 4 Grams per liter Molybdenum Trioxide, 2 Grams per liter. Free Potassium Cyanide, 15 Grams per liter. Potassium Hydroxide, 7½ Grams per liter. Nickel Cyanide, 2 Grams per liter Zinc Cyanide, 1.5 Grams per liter	Gold, over 90%. Molybdenum .005–.05%.

Solution IV

	Spectrographic Analysis of Plate .0003 of inch thick
Water: Fine Gold, 4.0 Grams per liter Uranyl acetate, 2.0 Grams per liter Free Potassium Cyanide, 15.0 Grams per liter. Free Potassium Hydroxide, 7.5 Grams per liter. Potassium Carbonate, 30.0 Grams per liter.	Gold, over 95%. Uranium 1–5%.

In plating from Solutions I, II, III and IV, the solutions in each case were made up in one liter of water, the anode used was stainless steel, the cathode was polished nickel, the current density was 15 amps./sq. ft. and the plating time was 30 minutes. The solutions were maintained between the temperature limits of 65° C. to 75° C. The plate obtained from these tests averages about 0.0003 inch in thickness. The spectrographic analyses of the plates deposited from Solution II indicated that uranium was deposited with the gold, and that the plate deposited from Solutions I and III showed that molybdenum was deposited with the gold and that the plate from Solution III also contained amounts of nickel and zinc. The plate obtained from Solution I had a Hamilton gold color, Solutions II and IV had a Hamilton-pink gold color, and Solution III had a Hamilton

gold color. The plate resulting from Solutions I, II, III and IV exhibited excellent wear-resistant characteristics.

In order to test the wear or abrasive-resistant characteristics of the plates resulting from the Solutions I, II, III and IV, they were compared to gold plates deposited from the following gold plating bath which may be considered representative of present day gold plating practice.

Representative solution

Water:	Grams per liter
Fine gold	4
Free potassium cyanide	7.5
Copper cyanide	2
Nickel cyanide	10
Potassium ferrocyanide	10

The representative solution yields a gold plate which is known generally as a Hamilton 14K.

The plates resulting from Solutions I, II, III and IV and the plate resulting from the representative gold plate solution were compared by subjecting them to abrasion by steel balls in a tumbling barrel. Gold plates produced from Solutions I, II, III and IV required between 30 to 60 minutes to burnish to a selected standard limit while those plates produced by the representative gold solution required only 5 to 10 minutes to burnish to the same degree; such tests accordingly demonstrated that wear resistance is enhanced approximately six-fold.

As noted above the characteristic yellow gold color which results when molybdenum is combined with gold has a relatively stable hue which does not change in character with variations in the amounts of soluble molybdenum compounds present in the plating solution. For example, the color of the plate resulting from Solutions I and III was substantially the same hue although the Solution I contained 4 grams of potassium molybdate per liter and Solution III contained 2 grams of molybdenum trioxide per liter. Spectrographic analysis of the plates resulting from Solutions I and III indicated that the molybdenum was present in the plate in substantially the same proportions even though the ratio of the molybdenum compound in the plate solution was substantially varied with respect to the amount of gold present in the solution.

Other soluble compounds of uranium and molybdenum which may be used in plating solutions effectively are:

Uranium phosphate
Uranium oxalate
Uranium benzoate
Metauranic acid
Molybdenum hydroxide
Molybdenum dihydroxytetrachloride
Molybdenum oxydichloride
Molybdenum thiocyanate
Molybdic acid

Gold plates containing molybdenum and uranium are more wear resistant and still maintain the colorations or have more desirable colorations than those presently obtainable and at the same time the plate contains sufficient gold to meet the standard requirements of electroplated gold. With the present invention, a gold plate of 0.00002 inch in thickness may be applied to an article and will have the same or greater wearing characteristics and useful life than a gold plate obtained of 0.00005 inch in thickness from the representative solution noted above. The cost of the final plate because of reduced plating time and because of less gold used is less than half of the cost of applying the thicker plate from the presently known gold plating solutions such as the plate from the representative solution. By the use of the invention a saving of at least 50% can be effected.

In addition to the saving in cost resulting from the use of a thinner gold plate, the more abrasive resistant

gold plate of this invention will provide a surface which will retain its original lustre longer and will be less subject to scratching than the gold plates which are presently in use.

Having thus described my invention, I claim:

1. An electrodeposited surface containing over 90% of gold and molybdenum in the range of .005 to .05% and characterized by a resistance to abrasion greater than a surface of the same gold content but which is free of molybdenum.

2. An electrodeposited surface having 90–95% gold and .05 to 5% uranium.

3. An electrodeposited surface containing over 90% of gold and uranium in the range of .05 to 5% characterized by a resistance to abrasion greater than a surface of the same gold content but which is free of uranium, and by a Hamilton-pink gold color.

4. An electroplating cyanide bath containing water, 4 grams per liter of fine gold, 15 grams per liter of free potassium cyanide, 4 grams per liter of potassium molybdate, 7½ grams per liter of potassium hydroxide.

5. An electroplating cyanide bath containing water, 4 grams per liter of fine gold, 30 grams per liter of potassium carbonate, 15 grams per liter of free potassium cyanide, 4 grams per liter of uranium nitrate.

6. An electroplating cyanide bath containing water, 4 grams per liter of fine gold, 15 grams per liter of free potassium cyanide, 7½ grams per liter of potassium hydroxide, 2 grams per liter of molybdenum trioxide, 2 grams per liter of nickel cyanide, 1.5 grams per liter of zinc cyanide.

7. An electroplating cyanide bath containing water, 4 grams per liter of fine gold, 15 grams per liter of free potassium cyanide, 7½ grams per liter of free potassium hydroxide, 30 grams per liter of potassium carbonate, 2 grams per liter of uranium acetate.

8. An electrodeposited surface containing over 90% gold with at least one metal from the group consisting of molybdenum and uranium, in the amount of about .05%, and characterized by a resistance to abrasion greater than a surface of the same gold content but which is free of molybdenum and uranium.

9. The method of producing an electrodeposited surface containing over 90% gold and uranium in the range of .05 to 5% on an article comprising, immersing said article in a gold cyanide bath containing water and 4 grams per liter of fine gold, 30 grams per liter of potassium carbonate, 15 grams per liter of free potassium cyanide, and 4 grams per liter of uranium nitrate, using said article as a cathode, and passing an electric current between said article and an anode disposed in the bath.

10. The method of producing an electrodeposited surface containing over 90% gold and uranium in the range of .05 to 5% on an article comprising, immersing said article in a gold cyanide bath containing water and 4 grams per liter of fine gold, 15 grams per liter of free potassium cyanide, 7½ grams per liter of free potassium hydroxide, 30 grams per liter of potassium carbonate, and 2 grams per liter of uranium acetate, using said article as a cathode, and passing an electric current between said article and an anode disposed in the bath.

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