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[54] **ELECTRO-GALVANIC GOLD PLATING PROCESS**

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[58] **Field of Search** ..... 204/46 G, 248, 249, 109

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[57] **ABSTRACT**

A gold plating arrangement is described which consists essentially of a plating bath consisting of 0.5 to 10 grams per liter lithium or potassium aurocyanide and 15 to 150 grams per liter ammonium chloride dissolved in water, and a base metal in contact with a second metal which occupies a higher position in the EMF series than gold or said base metal. The resultant plate is much denser than that obtainable by conventional electrolytic plating, thus serving as an effective corrosion protective surface against acid media.

3 Claims, No Drawings

ELECTRO-GALVANIC GOLD PLATING PROCESS

BACKGROUND OF THE INVENTION

The present invention relates to a gold plating process. It was made in the course of, or under, a contract with the U.S. Atomic Energy Commission.

It is a principal object of this invention to provide a novel gold plating bath composition as well as a method for utilizing said composition to achieve a thin, uniform, dense, and adherent gold plate deposited on a selected metal substrate in a method which requires no external source of electricity.

Because gold is virtually impervious to chemical attack in highly acidic media, it is ideally suitable for use as a protective coating or cladding on less corrosion-resistant metals such as copper, brass, monel (copper-nickel), nickel, and bronze. Electrolytic plating processes have routinely been used to apply a gold layer on metal substrates. Experience has shown, however, that the density of the gold plate is frequently insufficient to effectively insulate the metal substrate from corrosive media. In addition, the throwing power of electrolytic processes cannot reach inaccessible areas to guarantee uniform plating. The same objections apply to the technique of mercurial gilding in which a gold amalgam is painted or brushed on a work surface and then heated to volatilize the mercury. A uniform gold plate can be obtained by the so-called immersion method which simply involves immersion of a base metal in a suitable gold cyanide solution. Plating occurs by virtue of the electrochemical action resulting from proximity of two dissimilar metals, i.e., the plating metal (gold) and the base metal. However, as soon as a thin film of gold is deposited on the base metal, further plating stops because there is then no longer any dissimilar metal surface available to generate the required electrochemical action.

The present invention is similar to the immersion method in that it requires no external source of electricity to effect plating. However, it differs in that electrochemical action can be sustained over a long period of time to permit deposition of a thin, dense, adherent gold film of a desired thickness.

SUMMARY OF THE INVENTION

According to the invention, a sustained electro-galvanic action is obtained in a selected gold plating solution between a metal workpiece and a metal electrode in contact with said workpiece, in which said metal electrode occupies a higher position in the electromotive series than gold or the metal workpiece, with reference to *Lange's Handbook of Chemistry*, ninth Edition, p. 1,218, in a selected gold plating solution which has the capacity to dissolve the electrode metal and maintain its ions in solution. The gold plating bath in which sustained electro-galvanic and hence plating action takes place to permit practice of the process aspect of this invention is composed of 0.5 to 10 grams/liter lithium or potassium aurocyanide and 15–150 grams/liter ammonium chloride.

In practice, a given workpiece to be plated is immersed in the plating solution in contact with a selected metal electrode. The metal electrode serves as an anode while the surface of the workpiece serves as a cathode. Among metals which may serve as anode are nickel, magnesium, cobalt, iron, zinc, and aluminum. Among metals which may be effectively plated with the

plating bath are copper, nickel, brass, monel, and silver. The ammonium chloride dissolves the anode metal and maintains the resultant ions in solution, apparently as a chloride complex, over a pH range from 4.5 to 6.5. If the pH decreases below 4.5, hydrogen cyanide is released. The plating rate drops to almost zero at higher pH values.

An effective plating rate for producing an adherent, dense, protective gold plate occurs at a bath temperature of from 90° to 100° C. with a gold salt concentration in the range 0.5 to up to its maximum solubility, 10 grams/liter. A temperature lower than 90°C. or a lower gold salt concentration leads to impractically low plating rates for producing an effective corrosion protective plate but is suitable to form an ultra-thin plate useful as a decorative finish. When the bath temperature exceeds 100°C., hydrogen pitting of the plate occurs. For best results, the solution should be maintained at a temperature of 98°C. at a pH of 5.3 at a potassium aurocyanide concentration which does not fall below about 1 gram/liter. During plating, pH may be lowered with a HCl—NH_4Cl mixture or may be raised with a mixture of NH_4OH—NH_4Cl, and, as the gold in solution is consumed, make-up gold should be added. Under these conditions, plating rates will range from 0.25 to 100 microinches per hour to deposit a continuous, adherent, dense gold plate on all cathode surfaces of the base metal in contact with the bath. Although the plating rate is low in comparison to rates obtainable with electrolytic plating, the quality of the plating in terms of density is much higher to provide effective protection of the base metal from chemical attack by corrosive reagents. The quality of the plate in terms of corrosion protection is not a function of plate thickness so much as it is plate density.

The utility and advantages of this invention are illustrated in the following representative example.

EXAMPLE

A brass workpiece was immersed in a solution containing 1 gram/liter potassium aurocyanide and 75 grams/liter ammonium chloride in contact with a nickel anode, the nickel anode being in a cloth anode bag. Plating was performed at a temperature from 98° to 100° C. at a pH ranging from 5.3 to 5.5. After 20 hours, a uniform, continuous gold deposit 0.0003 inch thick formed on the workpiece. The plated part was immersed in a circulating solution of 15 percent hydrofluoric acid at a temperature of 85°C. After 27 hours no apparent corrosion was noted. A part which was electrolytically plated to 0.001 inch thickness and exposed to the same conditions was found to have been extremely corroded.

What is claimed is:

1. A method for depositing metallic articles with gold which comprises immersing said article in a plating bath maintained at a temperature in the range 90°–100°C and at a pH in the range 4.5–6.5, said bath consisting essentially of 0.5 to 10 grams/liter lithium or potassium aurocyanide and 15–150 grams/liter ammonium chloride, while said article is in electrical contact with a dissimilar metal which renders the article cathodic in said bath.

2. The method according to claim 1 in which the pH of the bath is maintained within the range 4.5–6.5 by addition of either HCl—NH_4Cl mixture or a mixture of NH_4OH—NH_4Cl.

3. The method according to claim 1 in which the dissimilar metal occupies a higher position in the electromotive series than gold or the metal article.

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