ELECTROPOLISHING OF GOLD AND GOLD ALLOYS

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The present invention relates to improvements in the electropolishing of gold and gold alloys.

In the previous processes for the electropolishing of gold and gold alloys, it has been necessary to subject the surface to be polished to a rather extensive preliminary polishing in order to obtain a satisfactory luster or polish. The baths previously employed for electropolishing only effectively removed rather inconsequential differences in the surface levels and, consequently, it was not possible to obtain satisfactory results upon roughly ground surfaces or surfaces which still exhibited a rolled texture without first subjecting them to prior mechanical treatment. As most of the previously employed baths are cyanide baths, the necessarily long treatments required, often give rise to surface defects in gold alloys which are easily subject to etching phenomena. Furthermore, after reaching a certain degree of evenness of the surface, the quantity of gold removed from the surface depressions is just as great as that removed from the surface elevations. The result of this is, especially upon long treatments, that the surface profile is displaced inwardly without obtaining an even surface.

It is an object of the invention to provide an improved electropolishing process for gold and gold alloys which not only avoids the aforementioned difficulties, but also produces an excellent luster and polishing effect to produce a high gloss without effecting excessive reductions in the profiles and without leaving incompletely removed texture contours.

According to the invention, it was unexpectedly discovered that the objects of the invention could be achieved if the electropolishing is carried out in baths which essentially consist of acid solutions of thiourea and the current employed is such that a surface film is formed upon the anodic surface to be polished. It is believed that these thin viscous surface films which are formed on the anode are caused by the precipitation of difficultly soluble gold-containing complex salts of thiourea with the acids or acid reacting components present in the baths according to the invention.

It was found that the required acid reaction of the thiourea baths can be obtained with any desired organic or inorganic acid, such as, for example, sulfuric acid, phosphoric acid, perchloric acid and phenol sulfonic acid, or acid-reacting salts or mixtures thereof. Especially good results have been obtained with sulfuric acid.

The quantity of free thiourea contained in the baths may vary within wide limits, but should, according to the invention, amount to at least 5 grams per liter and can be as great as the solubility limits of the thiourea. In certain circumstances, the normal solubility of the thiourea can be increased by the addition of suitable substances such as, for example, antipyrene. Especially good results are obtained with baths containing about 15 to 60 grams of thiourea per liter. Generally, the higher thiourea concentrations accelerate the procedure of the gold removal, but higher current densities are necessary. The baths, according to the invention, can be employed at temperatures up to 100° C., preferably, however, they are employed at temperatures between about 30° and 60° C.

The current, and especially the current density required to produce the films which are indispensable for the process according to the invention are dependent upon the thiourea concentration, as well as the temperature of the bath. They may, however, be easily ascertained for each selected bath composition and operating temperature by simple tests. The anode films remain on the surface being electropolished until the end of the electropolishing treatment. While such films are not always visible to the eye, they are detectable through cathodic polarization.

The electropolishing process according to the invention can be applied to pure gold as well as to the usual gold alloys containing alloying elements such as, for example, silver, copper, zinc, cadmium and nickel. The best effects are obtained if the gold alloys are of a fineness of at least 8 carats.

The following examples serve to illustrate preferred embodiments of the invention.

Example 1

An aqueous bath containing 25 grams of thiourea, 3 cubic centimeters of concentrated sulfuric acid and 10 grams of tartaric acid per liter was prepared and employed in the anodic electropolishing of coarsely emeried gold alloy sheets of the following composition: 58.5% Au, 10% Ag, 27.9% Cu and 3.6% Zn. The bath was maintained at a temperature between 20 and 45° C. The current densities employed were between 1.5 and 3.5 A./dm.2 at voltages between 2.0 and 4.5 volts.

After two minutes of anodic treatment, the gold alloy sheets had well polished surfaces and after five minutes' treatment, the surface had a high gloss which required no aftertreatment.

Example 2

A bath containing 50 grams of thiourea and 5 cubic centimeters of concentrated sulfuric acid per liter was employed to anodically polish gold alloy sheets of the same composition of the alloy of Example 1 at temperatures between 50° to 60° C., current densities between 3.5 and 6.5 A./dm.2 at voltages between 3 and 7 volts.

The time required for the electropolishing was substantially shortened by the use of a bath with a higher thiourea concentration and the use of higher temperatures and current densities than in Example 1.

Example 3

Gold alloy sheets containing 83.3% Au, 10% Ag and 6.7% Cu were anodically electropolished in a bath containing 50 grams of thiourea and 5 cubic centimeters of concentrated sulfuric acid per liter at a temperature of 25° C. and current densities between 2.0 to 4.3 A./dm.2 at voltages between 1.2 and 4.0 volts.

Example 4

A gold alloy containing 75% Au, 10% Ag and 15% Cu was anodically electropolished in a bath containing 25 grams of thiourea and 70 cubic centimeters of concentrated sulfuric acid per liter at a temperature of 25° C. and current densities between 1.5 and 1.6 A./dm.2 at voltages between 2.0 and 4.5 volts.

Example 5

Gold alloy sheets of the composition of those of Example 3 were anodically electropolished in a bath containing 100 grams of thiourea and 5 cubic centimeters of concentrated sulfuric acid per liter at a temperature of 25° C. and a current density of more than 2.4 A./dm.2 at 5 volts.
Example 6

Stumped gold rings containing 58.5% Au, 10% Ag, 27.9% Cu and 3.6% Zn which still had the stamping burr were anodically polished in a bath containing 25 grams of thiourea and 100 cubic centimeters of concentrated sulfuric acid per liter at a temperature of 25° C. and a current density of more than 1.3 A./dm.² at 2.3 volts. The rings not only received a high polish, but were also completely deburred in the single electropolishing operation. Previously it was always necessary to deburr the objects mechanically before electropolishing, for example, by a tumbling operation which led to unavoidable losses. The gold removed from the electropolished objects can be recovered quantitatively from the bath according to the invention.

Example 7

Dental prosthesis formed partly of the alloy of Example 3 and partly of the alloy of Example 4 joined by a solder composed of 75% Au, 4% Ag, 13% Cd, 4% Zn and 4% Cu were anodically electropolished in a bath containing 50 grams of thiourea and 5 cubic centimeters of concentrated sulfuric acid at 47° C. and current densities between 2.8 and 9.2 A./dm.² at voltages between 3 to 7 volts.

Example 8

A gold alloy containing 33.3% Au, 12% Ag, 37.8% Cu, 0.5% Ni and 16.4% Zn was anodically electropolished in a bath containing 25 grams of thiourea and 10 cubic centimeters of concentrated sulfuric acid per liter at 60° C. and at current densities between 1.3 and 7.3 A./dm.² at voltages between 1.5 and 5.2 volts.

The process according to the invention not only renders it possible to produce a high gloss on rougher gold and gold alloy surfaces than was heretofore possible, but also simultaneously can be employed to deburr the object being electropolished. Thus, for example, rough stamped objects can be simultaneously polished and deburred in one operating step. Another considerable advantage of the process according to the invention is that it avoids the use of cyanides which, because of their poisonous nature, are dangerous to use. It was furthermore completely unexpected that the process according to the invention would produce the excellent results which are obtained therewith, as the operating conditions employed, namely, conditions under which anodic film formation takes place, normally are studiously avoided in galvanic processes.

I claim:
1. A process for polishing surfaces of gold and gold alloys of a fineness of at least 8 carats which comprises anodically electropolishing such surfaces in an aqueous electrolytic bath essentially consisting of water, a minor proportion of at least one acid to acidify said bath and at least 5 grams of thiourea per liter at a temperature up to 100° C. and at current densities which cause the formation of a film upon the surfaces treated.
2. A process according to claim 1, in which the temperature of the bath is between 30° and 60° C.
3. A process according to claim 1, in which the bath contains 15 to 60 grams of thiourea per liter.
4. A process according to claim 1, in which said bath contains sulfuric acid.
5. A process according to claim 1, in which said bath contains antipyrine to increase the solubility of the thiourea.
6. A process according to claim 1, in which said bath contains sulfuric and tartric acid.

References Cited in the file of this patent

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