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ELECTRODEPOSITION OF ANTIMONY AND ANTIMONY ALLOYS

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This invention relates to improvements in the electrodeposition of antimony and alloys containing antimony.

I have discovered that hard, smooth, bright and highly corrosion-resistant deposits of antimony and alloys of antimony can be electroplated by inclusion of certain addition agents in electroplating baths. The preferred addition agent in accordance with the present invention is the tetra sodium salt of ethylene diamine tetra acetic acid. Under some conditions the mono, di, and tri sodium salts of ethylene diamine tetra acetic acid may be used in place of the tetra sodium salt. The potassium salts also may be employed in place of the sodium salts.

While the addition agents in accordance with the present invention may be employed in any known type of bath or electrolyte for electrodepositing antimony or alloys of antimony, most satisfactory results have been obtained from aqueous solutions containing the addition agent together with ammonium citrate (dibasic) and antimony potassium tartrate (tartar emetic). To this antimony plating bath is added such other soluble metal salt or compound as may be desired to obtain the desired antimony alloy electrodeposit. For example, I have successfully electrodeposited alloys of antimony-lead, antimony-copper, antimony-iron, antimony-cadmium, antimony-indium, antimony-tin and antimony-zinc.

The antimony or antimony alloy plates may be deposited to any desired thicknesses. The antimony and antimony alloy plates are especially advantageous as decorative and corrosion-resistant plates. For this type of electrodeposit, plate thicknesses up to .002" or more may be employed. A thickness of .0015" is typical. If desired the antimony or antimony alloy electrodeposit may have an electrodeposit of chromium applied thereon.

The following is a specific and illustrative example of a satisfactory plating bath for electrodepositing antimony in which the named ingredients are employed in the amounts stated per liter of water:

80 to 200 grams of ammonium citrate (dibasic)
10 to 80 grams of antimony potassium tartrate (tartar emetic)
30 to 60 grams of tetra sodium salt of ethylene diamine acetic acid

Where it is desired to plate an alloy of antimony-lead, 10 to 25 grams of lead oxide (PbO) may be added to the foregoing bath. An equal amount of lead acetate may be employed in place of the lead oxide. Citric acid and ammonium hydroxide in proper proportions may be used in lieu of dibasic ammonium citrate. Where an alloy of antimony-lead consisting predominantly of antimony is desired the bath may contain from 40 to 80 grams of antimony potassium tartrate and 20 grams of lead oxide or lead acetate per liter of water. Lower concentrations of antimony potassium tartrate are used in electrodepositing antimony-lead alloys in which the lead is the predominant constituent. Such high lead content antimony alloys are very ductile and harder and whiter than lead. They provide a good underplate for the high antimony-lead alloys.

In the foregoing baths very satisfactory results have been obtained with voltages of 1 to 4, current densities of 5 to 50 amperes per square foot of cathode area, bath temperatures ranging from room temperature or below up to 125° F. or higher, and with the pH of the bath ranging from about 4 to 6 (5 preferred). If necessary to maintain the pH within this range small amounts of hydrochloric acid or sulfuric acid may be added.

For plating an alloy consisting largely of antimony with a minor amount of copper the antimony plating bath described above may have added thereto from about .4 to 2 grams of copper sulphate per liter of water. Deposits of exceptional brightness are obtained from the antimony plating bath to which copper has been added.

For making a plating bath for electrodepositing antimony-tin alloys the antimony plating bath described above may have added thereto 20 cc. of stannous fluoborate (46% solution) per liter of water.

For making a plating bath for electrodepositing antimony-cadmium alloys the antimony bath described above may have added thereto from about 10 to 25 grams per liter of a soluble cadmium compound, for example, cadmium sulfate or cadmium chloride.

For making a plating bath for electrodepositing antimony-indium alloys the antimony bath described above may have added thereto about 10 to 40 cc. per liter of a 50% solution of indium chloride in water.

The anodes employed may be of pure antimony. In the case of the electrodeposition of alloys of antimony the anodes may, if desired, consist of an alloy of antimony with the alloying metal to be electrodeposited. The foregoing baths all provide good anode corrosion.

The antimony or alloys of antimony may be electroplated on cathodes of any of the common metals; for example, iron or steel, copper, lead, tin, nickel, cadmium, indium, zinc, etc.

In plating of steel, brass, and zinc-base die castings, a presently preferred sequence of plating is to (1) apply a lead flash or strike in an alkaline lead plating bath containing tetra sodium salt of ethylene diamine tetra acetic acid; (2) then electrodeposit a lead-antimony plate (an alloy high in lead); (3) and then electrodeposit an antimony-lead plate (an alloy high in antimony) or an antimony-copper plate (alloy high in antimony). A satisfactory alkaline lead plating bath is one containing per liter of water, about 100 to 120 grams of Rochelle salts, 10 to 25 grams of lead oxide, lead acetate, or lead carbonate, 15 to 75 grams of tetra sodium salt of ethylene diamine tetra acetic acid. Sodium hydroxide may be added as needed to maintain the pH at about 9 to 11. Lead anodes may be used. An indium or tin strike may be employed in place of the lead strike if desired. Where copper is used as an underplate it is preferred (because of the possibility of reaction between copper and antimony) to apply a strike or flash of lead, indium, or lead-antimony alloy high in lead over the copper, before plating with the high antimony alloy.

Various changes and modifications of the embodiments of my invention disclosed herein may be made by those skilled in the art without departing from the principles and spirit of the invention.

I claim:

1. An electroplating bath consisting essentially of an aqueous solution containing ammonium and citrate ions, antimony potassium tartrate, a soluble compound of a metal other than antimony and an alkali metal salt of ethylene diamine tetra acetic acid in a small but effective amount of to about 60 grams per liter.

2. A plating bath as in claim 1 in which the alkali metal salt is the tetra sodium salt of ethylene diamine tetra acetic acid.

3. An electroplating bath consisting essentially of an aqueous solution of ammonium citrate, antimony potassium tartrate, and a small but effective amount up to about 60 grams per liter of an alkali metal salt of ethylene diamine tetra acetic acid.

4. An electroplating bath as in claim 3 in which the bath also has dissolved therein a soluble compound of a metal other than antimony.

5. A plating bath consisting essentially of the following per liter of water:

80 to 200 grams of dibasic ammonium citrate,
10 to 80 grams of antimony potassium tartrate,
30 to 60 grams of tetra sodium salt of ethylene diamine tetra acetic acid.

6. An electroplating bath consisting of the following per liter of water:

80 to 200 grams of dibasic ammonium citrate,
10 to 80 grams of antimony potassium tartrate,
30 to 60 grams of tetra sodium salt of ethylene diamine tetra acetic acid,
10 to 25 grams of lead oxide (PbO).

7. The method of electroplating which comprises passing an electric current from an anode to a cathode through the bath defined in claim 6.

8. An electroplating bath consisting essentially of the following per liter of water:

80 to 200 grams of ammonium citrate,
10 to 80 grams of antimony potassium tartrate,
30 to 60 grams of a compound of the class consisting of mono, di and tri alkali metal salts of ethylene diamine tetra acetic acid.

9. An electroplating bath as in claim 8 to which has been added a soluble compound of a metal of the class consisting of lead, copper, tin, cadmium, iron, zinc and indium.

10. An electroplating bath consisting essentially of an aqueous solution containing ammonium and citrate ions, antimony potassium tartrate, a soluble compound of a metal of the class consisting of lead, copper, tin, cadmium, iron, zinc and indium, and about 30 to 60 grams of an alkali metal salt of ethylene diamine tetra acetic acid per liter of solution.

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