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3,063,850

METAL PLATING BY CHEMICAL REDUCTION WITH AMINE BORANES

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This invention relates to chemical deposition of certain metals upon other metals, glass, ceramics and plastics by the reducing action of isopropylamine borane in an aqueous solution of a salt of the plating metal.

A process for chemical plating nickel and cobalt upon metallic surfaces has been proposed which involves the reducing action of hypophosphites in a solution of a nickel or cobalt salt, a temperature of 90° C. or more being used to start the reaction. A process also has been proposed involving the reducing actions of hypophosphites and hydrazine, a noble metal catalyst being used to start the reaction.

It is known that the alkali metal borohydrides reduce nickel salts but the reduction product is nickel boride. Thus, the United States patent to H. I. Schlesinger and H. C. Brown No. 2,461,661, column 5, lines 2 to 5, states "One characteristic reduction reaction of the alkali metal borohydrides is the reduction of nickel sulfate in solution to a black precipitate of nickel boride, Ni_2B ." In view of the close chemical relationship of the alkali metal borohydrides to the amine boranes, it might be expected that the amine boranes would reduce metal salts in solution and that the reduction product would be the corresponding metal boride.

The copending application of Edward A. Sullivan, Serial No. 788,715, filed January 26, 1959, now U.S. Patent No. 2,942,990, describes a method for chemical plating nickel and cobalt by reducing nickel or cobalt salts with alkali metal borohydrides in an aqueous solution having a pH between 12.0 and 13.0. In such a solution the boride formation is suppressed and the reduction product is principally elemental metal.

The present invention is based upon the discovery that isopropylamine borane is an effective reducing agent for use in chemical plating of certain metals upon other metals and non-metals, such as glass, ceramics and plastics. The plating bath of the invention consists essentially of an aqueous solution of a metal salt and isopropylamine borane in a molar ratio between about 2 to 1 and 10 to 1, the concentration of isopropylamine borane being between about 1 to 2 grams per liter. The metal salt may be any water soluble salt of nickel, copper, cobalt, cadmium or tin, such as the sulfate, chloride, nitrate, acetate or formate of nickel, copper or cadmium, the sulfate, nitrate, acetate or formate of cobalt, tin sulfate and stannous chloride.

In my present preferred practice, the body to be plated is immersed in an aqueous bath containing about 2 grams of isopropylamine borane per liter and in which the molar ratio of metal salt to isopropylamine borane is about 3 to 1 while maintaining the bath at a temperature between 70 to 85° C. A good adherent plating is obtained in from

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about one-half to one hour. When the temperature of the bath is lower, such as between 40 to 50° C., a longer plating period up to about 3 hours is required to obtain a plating of the same thickness.

The invention is illustrated further by the following example.

A copper sample (2 in. x 2 in. x 0.022 in.) was degreased with carbon tetrachloride, followed by rinsing with water. The sample then was washed in detergent solution and rinsed with water. The sample then was immersed for 20 seconds in 3:1 $H_3PO_4-HNO_3$, followed by rinsing with water, and stored in water until placed in the plating bath.

The plating bath was prepared by dissolving 70 grams of $NiCl_2 \cdot 6H_2O$ and 2 grams of isopropylamine borane in distilled water separately, filtered and mixed just before immersion of the metal sample, the total amount of water being one liter.

With the sample in place, the bath was heated at 40–50° C. in an open glass beaker, with stirring, to initiate the reaction. After 3 hours a satisfactory adherent coating of nickel had been deposited upon the sample and the wall of the beaker.

In other runs, similar results were obtained in periods of one-half to one hour when the bath was heated between 70° C. and 85° C.

Similar results were obtained using an aqueous bath containing 20 grams $NiCl_2 \cdot 6H_2O$ (0.084 mole Ni^{++}) and 2.0 grams isopropylamine borane (0.027 mole BH_3) per liter of solution.

Similar results also were obtained using various other aqueous baths in which the nickel chloride was replaced by water soluble salts of cobalt, copper, cadmium and tin, such as cobalt nitrate, copper acetate, cadmium chloride and stannous chloride.

I claim:

1. A bath for plating by chemical deposition consisting essentially of an aqueous solution containing a metal salt and isopropylamine borane in a molar ratio between about 2 to 1 and 10 to 1, the concentration of isopropylamine borane in said solution being between about 1 to 2 grams per liter, said metal salt being selected from the group consisting of water soluble salts of nickel, copper, cadmium, cobalt and tin.

2. A bath for plating by chemical deposition as claimed by claim 1 wherein the metal salt and the isopropylamine are present in the molar ratio of about 3 to 1.

3. A bath for plating by chemical deposition as claimed by claim 1 wherein the metal salt is nickel chloride.

4. A bath for plating by chemical deposition as claimed by claim 2 wherein the metal salt is nickel chloride.

References Cited in the file of this patent

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