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2,870,070

ELECTRODEPOSITION OF TIN AND ELECTROLYTE THEREFOR

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This invention relates to the electrodeposition of tin, particularly to the plating of tin on steel, and an electrolyte for use therein.

The electrodeposition of tin on a traveling base strip of steel is now practiced extensively. Both acid and alkaline electrolytes are in use. Our invention relates to an improvement in electrolytes of the acid type and the method involving the use thereof. According to the invention, we provide an electrolyte containing sulfamic acid and tin ions as well as an addition agent. The addition agent is a water-soluble organic compound which causes the deposited tin to form a layer which brightens when melted.

The sulfamic radical has heretofore been thought unsuitable for a tin-plating electrolyte, apparently because tin sulfamate is practically insoluble in water (Piontelli et al., "The Use of Sulfamate Baths in Plating and Electrometallurgy," *Chimica e Industria* 21, 478). Cupery Patent No. 2,318,592 significantly omits tin from the metals which may be deposited from sulfamate electrolytes. We have found, however, that a ductile, adherent coating of tin may be electroplated on steel from a solution of sulfamic acid and a tin salt, containing a suitable addition agent.

In a preferred practice, we prepare an electrolyte by dissolving sulfamic acid in water to a concentration of from 30 to 80 g./l. and add a stannous salt such as the sulfate in an amount sufficient to give from 15 to 50 g./l. of stannous ions. To this solution we further add one of the reagents used in phenolsulfonic-acid electrolyte for tin-plating, viz., diethyl, trimethyl or tetraethyl dihydroquinoline to a concentration of from .2 to 8 g./l. As alternatives, we may use dihydroxydiphenylsulfone or bisparahydroxyphenyl propane. Dihydroxybenzophenone may be substituted for any of the above addition agents to a concentration of 2 to 10 g./l.

The following formula is one specific example of our electrolyte:

Water in desired quantity plus
50 g./l. sulfamic acid
64 g./l. stannous sulfate
5 g./l. dihydroxydiphenylsulfone

Instead of the sulfate, other salts such as stannous fluoborate may be used in amounts providing a corresponding concentration of tin ions.

Using an electrolyte as above, we immerse a steel article such as thin strip or a sheet therein and make it the

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cathode with a current density of about 250 a. s. f. The temperature of the bath should be about 115° F. The current density may, however, vary between 150 and 500 a. s. f. and the temperature between 90 and 125° F. If the treatment is continuous, as in ordinary commercial production, the strip may have a speed of from 200 to 1000 F. P. M. The strip should preferably be in contact with the solution for from 5 to 15 seconds, depending on the current density and the amount of plating desired. The addition agent (dihydroquinoline, dihydroxydiphenylsulfone, bispara-hydroxyphenyl propane or dihydroxybenzophenone) serves to make the deposited tin layer brighten when melted by subsequently heating the base metal.

The electrolyte of our invention makes it possible to deposit a smooth adherent layer of tin. The electrolyte is easy to make up, has a high conductivity permitting high current densities to be maintained, and will tolerate contamination by various impurities. The tin layer deposited therefrom is ductile as well as adherent, and brightens when melted.

The use of sulfamic acid in the electrolyte has several important advantages. It is solid, non-hygroscopic and nonvolatile, and is therefore easy to ship and handle. It is less corrosive than sulfuric acid, is very soluble in water and is highly ionized in solution. Sulfamic acid is available commercially at prices lower than phenolsulfonic acid and is safer to handle than sulfuric acid.

Although we have disclosed herein the preferred practice of our invention, we intend to cover as well any change or modification therein which may be made without departing from the spirit and scope of the invention.

We claim:

1. As an electrolyte for tin plating, a water solution containing from 30 to 80 g./l. of sulfamic acid, from 15 to 50 g./l. of stannous ions, and from .2 to 10 g./l. of an addition agent selected from the group consisting of diethyl, trimethyl, tetramethyl dihydroquinoline, dihydroxydiphenylsulfone, bisparahydroxyphenyl propane, and dihydroxybenzophenone.

2. In a method of tin-plating on steel, the steps of immersing an article of steel in an electrolyte consisting substantially of water, from 30 to 80 g./l. of sulfamic acid, from 15 to 50 g./l. of stannous ions and from .2 to 10 g./l. of an addition agent selected from the group consisting of diethyl, trimethyl, tetramethyl dihydroquinoline, dihydroxydiphenylsulfone, bisparahydroxyphenyl propane, and dihydroxybenzophenone and making the article cathode with a current density of from 150 to 500 a. s. f.

References Cited in the file of this patent

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60 Piontelli et al.: *La Chimica e l'Industria*, vol. 21 (1939), pp. 478-491.