

UNITED STATES PATENT OFFICE

2,489,523

ELECTRODEPOSITION OF TIN OR LEAD-TIN ALLOYS

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No Drawing. Application February 9, 1944,
Serial No. 521,654

9 Claims. (Cl. 204—43)

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The invention relates to the electrodeposition of tin or alloys of tin and particularly alloys consisting principally of lead and tin.

Lead-tin alloys are useful in various industrial fields, for example, as coatings to protect base metals against corrosion, and as bearings or parts thereof. The presence of a small proportion of tin in lead prevents the lead from being attacked and dissolved by corrosive acids that are produced in lubricating oils, especially at high temperatures. Accordingly, it is common practice to employ such alloys as bearing "babbitts" or for bearing surfaces.

It is well known that alloys of lead and tin can be deposited electrolytically, and baths in which the metals are present in the form of fluoborates have been used for that purpose. Such baths, however, are inconvenient for several reasons and are difficult to control. I have found that baths in which the metals are present as compounds of sulfamic acid provide a more satisfactory operation and better deposit.

Sulfamate baths for deposition of lead alone are known and are disclosed, for example, in Patent 2,318,592, Cuperty, May 11, 1943. In accordance with the present invention, I use a sulfamate bath containing tin to which, if it be desired to deposit a lead-tin alloy, a suitable quantity of lead sulfamate may be added to form a bath from which both lead and tin may be readily deposited.

As an illustration of one method of making up a tin sulfamate bath, I have formed the tin salt by electrolytic action in a bath containing sulfamic acid and tin anodes. For example, a solution of 50 gr. sulfamic acid in 1 liter of water may be provided. Upon placing in such solution a tin anode and copper cathode and passing therethrough current at approximately 12 amperes per sq. ft. of cathode area, operating at room temperature, a visible deposit of tin will be obtained almost immediately. After electrolysis for several hours, analysis of the bath will show the presence of tin to the amount of upwards of 5 gr. per liter.

Tin may be deposited from such a bath even though a carbon anode be substituted for the tin anode. The use of tin anodes is, however, preferable in order to maintain the tin content.

If it be desired to make up a bath from which both lead and tin can be deposited simultaneously, a tin bath constituted as above may have added thereto lead sulfamate or a salt of lead which will dissolve in the bath with the formation of the sulfamate, for example, lead carbon-

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ates. If a bath so made is electrolyzed, preferably with anodes containing both tin and lead, an alloy of the two metals is deposited. With the use of anodes of 10% tin and 90% lead, for example, the content of tin in the deposit, which may be low at first, will increase until it reaches approximately the same proportion as that present in the anodes.

As another example of a method of making up a bath for plating a lead-tin alloy, I have used a lead plating bath constituted in accordance with the above mentioned patent, and passed through it current at about forty amperes per square foot, with tin anodes, for about sixty hours at room temperature. At this time a deposit was obtained containing approximately 15% of tin. Upon restoring the original lead content of the bath, by addition of one-half pound per gallon of lead sulfamate plating salts, the deposit then obtained, when analyzed, showed the alloy to be approximately 10% tin and 90% lead. The initial tin content of the bath can, of course, be made less or greater by correspondingly decreasing or increasing the time of electrolysis. If any sludge appears, the bath may be filtered. It will also be understood that the conditions given above are by way of illustration merely, and may be widely varied.

In operating the baths for plating, I find that the temperature should not exceed 115° F., and should preferably be about room temperature, cooling coils being used if necessary. Such coils, and the tanks also, should, of course, be protected against action of the acid as by rubber or glass coatings or other commercial acid-resistant material. The pH of the bath may be regulated by additions of sulfamic acid to approximately 1.4-2.4.

In planting the lead-tin alloy, the current density is an important factor, especially as the percentage of tin in the deposit increases with increase in current density. With the bath constituted as above set forth, the tin content of the deposit can be varied from between 5% and 10% at 20 amps. per sq. ft. to as high as 30% at 90 to 100 amps. It is therefore desirable, in order to obtain a fairly uniform composition of alloy on different plated areas, so to arrange the anodes that a correspondingly uniform current density is secured. In general, a current density of 10-30 amps. per sq. ft. of cathode area is recommended, although, with agitation, as high as 75 amperes may be satisfactorily employed and higher temperatures than are desirable in a still bath. Suitable agitation may be effected by cathode move-

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ment at about 6-20 ft. per minute. By suitable regulation of bath content and current density, I have obtained deposits as desired, ranging from approximately 1% to as high as 30% tin, with variations in different areas of not more than about 1-2%. Thorough cleaning of the base metal is required in order to secure good adhesion of the deposit.

As above pointed out, I prefer to maintain the metal content of the bath by solution of suitable anodes. In the case of the lead-tin bath, these anodes should be of the same composition as that desired in the deposit. Since anodes containing lead and/or tin readily dissolve during electrolysis, I have not found it necessary to add salts to maintain the metal content of the baths.

I claim:

1. The process of producing an electrolytic bath for deposition of tin consisting essentially in providing an aqueous solution of sulfamic acid, electrolyzing said solution with an anode of tin and forming thereby in said solution a compound of tin with sulfamic acid.
2. The process of preparing an electrolytic bath for simultaneous deposition of tin and lead consisting essentially in providing an aqueous solution of sulfamic acid, placing in said solution an anode of tin, electrolyzing said solution, thereby forming therein a compound of tin with sulfamic acid soluble in said solution adding to the solution lead sulfamate, and adjusting the sulfamic acid content to result in a pH of approximately 1.4 to 2.4.
3. The process of preparing an electrolytic bath for simultaneous deposition of lead and tin consisting essentially in providing an aqueous solution of sulfamic acid and lead sulfamate, electrolyzing said solution with the use of a tin anode until a lead-tin deposit is obtained in which the tin content is between 1% and 30%, then adding to the bath a compound of lead capable of restoring the lead lost by electrodeposition.
4. An electrolytic bath from which tin may be electrodeposited consisting essentially of an aqueous solution of sulfamic acid and a com-

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pound of tin formed by reaction between tin and sulfamic acid by electrolysis of a tin anode in an aqueous sulfamic acid solution, said compound being readily soluble in such solution.

5. A bath for electrodeposition of an alloy of lead and tin, said bath consisting essentially of an aqueous solution of sulfamic acid, lead sulfamate, and the product of reaction between tin and sulfamic acid produced by electrolyzing a tin anode in an aqueous solution of sulfamic acid.

6. A bath for electrodeposition of an alloy of lead and tin consisting essentially of an aqueous solution of sulfamic acid, lead sulfamate and the product of electrolyzing a tin anode in an aqueous sulfamic acid solution, said product and the lead salt being present in quantities sufficient to yield, upon electrolyzing a deposit of lead-tin alloy having 1% to 30% tin.

7. The process of electrodepositing an alloy of lead and tin by electrolyzing an aqueous solution having as its essential ingredients water, sulfamic acid, lead sulfamate and a compound of tin and sulfamic acid, the lead and tin salts being present in proportions to yield a deposit having a tin content of 1% to 30%.

8. The process as set forth in claim 7 including maintaining the content of tin and lead in the solution by use of anodes having approximately the content of the alloy to be deposited.

9. The process as set forth in claim 7 including maintaining the solution at a pH of approximately 1.4 to 2.4 by adjustment of the sulfamic acid content.

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REFERENCES CITED

The following references are of record in the file of this patent:

- Chemical Abstracts, vol. 34 (1940), pp. 677, 678.
- Transactions of the Electrochemical Society, vol. 40 (1921), p. 291.
- Chimica E Industria (Italy), 21, pp. 478-491 (1939).