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## METHOD OF ELECTRODEPOSITING CHROMIUM DIRECTLY ON ALUMINUM

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This invention relates to electrodepositing chromium directly on aluminum and provides improvements therein.

The present invention provides a method of electrodepositing chromium directly on aluminum with good adherence and without limit as to thickness, particularly as affecting the adherence of the chromium to the aluminum.

The procedure which is followed in carrying out said method is as follows:

(1) An aluminum article on which chromium is to be electrodeposited is immersed for about 10 to 15 seconds in an aqueous alkaline zincate cupro-cyanide solution from which an immersion coating of zinc and copper is deposited on the aluminum. The preferred composition of the dip solution for providing the immersion coating of zinc and copper is as follows:

| | Bath solution |
|---|---|
| Zinc oxide | 90 g./l. (12 ozs./gal.) |
| Sodium hydroxide | 429 g./l. (60 ozs./gal.) |
| Copper cyanide | 7.5 g./l. (1 oz./gal.) |
| Sodium cyanide | 15 g./l. (2 ozs./gal.) |

44° Baumé at 80° F.

To prepare and replenish the above dip solution a solid composition of matter may be used containing by weight:

| | Per cent |
|---|---|
| Zinc oxide | 16.6 |
| Sodium hydroxide | 79.3 |
| Copper cyanide | 1.4 |
| Sodium cyanide | 2.7 |

The alkali metal zincate solution of Hewitson Patent No. 1,627,900 is not a substitute for the alkaline zincate cuprocyanide solution.

(2) The zinc and copper immersion coating on the aluminum article is removed, a concentrated aqueous solution of nitric acid, in which the coated aluminum article is immersed, being used for this purpose. The article is immersed for 10 to 15 seconds, with the nitric acid solution at room temperature, this being sufficient time for the removal of the zinc and copper immersion coatings.

(3) The aluminum article is immersed for a second time in the aqueous alkaline zincate cuprocyanide solution referred to above, the time of immersion being usually between 10 and 15 seconds. The aluminum article when it comes out of the bath has another zinc and copper immersion coating thereon. The second immersion in the alkaline zincate cuprocyanide dip is used since the first zinc and copper immersion coating has a tendency to be non-uniform and does

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not dissolve instantly on immersion in a chromium plating bath. Unless the second dip is used, the adhesion of the chromium electrodeposit will be more critical and less dependable.

(4) The aluminum article with the zinc and copper immersion coating thereon is then immersed in a known chromic acid-catalyst acid radical chromium plating bath. The zinc and copper immersion coating on the aluminum article being extremely thin, will dissolve almost instantly following immersion in a standard chromium plating bath, at both room and elevated temperatures. The aluminum article is connected in an electric circuit as a cathode, but the circuit connection need not necessarily be made at the time the zinc and copper coated aluminum article is first immersed in the solution. However, the circuit should be completed so that electric current passes to the aluminum article (from which the zinc and copper immersion coating has been removed) within 15 seconds after the article has been immersed in the chromium plating electrolyte. The plating of the aluminum can be conducted as long as may be necessary to obtain a desired thickness of chromium. Chromium deposits of several thousandths of an inch have been obtained without any effect on the good adherence of the chromium to the aluminum being indicated.

In accordance with usual good practice in electroplating, the aluminum article is rinsed in water after removal from each dip solution and bath, and moreover, and also in accordance with good practice in electroplating, the aluminum article is given a preliminary cleaning. Also it is the usual practice in plating on aluminum to etch the surface.

A suitable preliminary cleaning and etching procedure is as follows:

The finished aluminum article is first degreased by dipping in a grease solvent such as trichlorethylene. Then it is dipped in an alkaline solution, which solution may be a 50 g./l. sodium hydroxide solution having a temperature of about 150° F. The akaline solution slightly etches the aluminum. Upon removal from the alkaline solution the aluminum article is rinsed with water and thereafter dipped in an acid pickle for about 1 to 5 minutes. The acid pickle may consist of $CrO_3$—35 g./l.; and $H_2SO_4$—173 g./l., and have a temperature of 150° F. After removal from the acid pickle the aluminum article is again given a water rinse, and is then dipped in a concentrated nitric acid (aqueous) solution for 5 to 10 seconds at room temperature. Following

the nitric acid dip the aluminum article is given another water rinse.

The foregoing procedure has been found to be applicable for plating chromium directly on aluminum and aluminum alloys designated in the trade Alloys 2S, 3S, 17S, 24S, 52S, and 61S.

*Nominal composition of wrought aluminum alloys*

| Alloy | Percent of Alloying Elements—Aluminum and Normal Impurities Constitute Remainder | | | | |
|---|---|---|---|---|---|
| | Copper | Silicon | Manganese | Magnesium | Chromium |
| 2S | | | | | |
| 3S | | | 1.2 | | |
| 17S | 4.0 | | 0.5 | 0.5 | |
| 24S | 4.5 | | 0.6 | 1.5 | |
| 52S | | | | 2.5 | 0.25 |
| 61S | 0.25 | 0.6 | | 1.0 | 0.25 |

In general the foregoing procedure has been found to give satisfactory results with aluminum alloys having a magnesium content less than about 2.5 per cent and silicon content less than 2 per cent. For higher silicon content alloys and for aluminum castings containing less than about 2.5 per cent magnesium, the following modified procedure can be followed. In the preliminary cleaning, before the immersion of the aluminum article in the acid pickle, the aluminum article is given an additional dip in a solution of nitric and hydrofluoric acids, such as one containing 3 parts concentrated nitric acid (70% by weight) to 1 part of concentrated hydrofluoric acid (29% by weight) for about 3 to 5 seconds. Alternatively, after the removal of the aluminum article from the acid pickle it may be scrubbed with a tampico brush to remove loosely adherent smut.

The time of the immersion of the aluminum article in the alkaline zincate cuprocyanide solution is a matter of importance, and for aluminum and the alloys listed above the time of immersion should not exceed the given values. It is possible that other less common aluminum alloys may require more or less time of immersion in the alkaline zincate cuprocyanide solution. The exact time limits for any particular alloys can be determined by making a preliminary test.

The present method of electroplating chromium on aluminum has results which differ from prior practice in two important particulars. The chromium is directly bonded to the aluminum, and any thickness of chromium desired can be electroplated directly on the aluminum. Chromium thicknesses from 10 to 15 mills have been obtained without any spalling, blistering or any other indication of poor or faulty adhesion.

What is claimed is:

1. A method of electrodepositing chromium directly on aluminum, consisting essentially of immersing an aluminum article to be electroplated for about 10 to 15 seconds in an aqueous alkaline zincate cuprocyanide solution to form a zinc-copper immersion coating thereon, removing said article and immersing the same in a nitric acid solution to remove said zinc-copper immersion coating, immersing the article a second time for not more than 15 seconds in the aqueous alkaline zincate cuprocyanide solution to form another zinc-copper immersion coating thereon, removing the article from the latter solution, then immersing said coated article in a chromic acid chromium plating bath to completely strip the zinc-copper immersion coating and within 15 seconds passing electric current to said immersed stripped aluminum article as a cathode to electrodeposit chromium thereon, thus producing a chromium plated aluminum article having no intermediate coating between the chromium and the aluminum.



2. A method of electrodepositing chromium directly on an aluminum-containing article selected from the class consisting of articles of aluminum and high aluminum alloys, consisting essentially of immersing the article to be electroplated in an aqueous alkaline zincate cuprocyanide solution to form a zinc-copper immersion coating thereon, removing said article from the solution and dissolving said zinc-copper immersion coating therefrom, immersing the article a second time in the aqueous alkaline zincate cuprocyanide solution to form another zinc-copper immersion coating thereon, removing the article from the latter solution, then immersing said article in a chromic acid chromium plating bath to completely remove the zinc-copper immersion coating thereon by the action of the chromium plating solution, and, immediately after the removal of said coating, electrodepositing chromium thereon, thus producing a chromium plated article having no intermediate coating between the chromium and the article.

3. A method of electrodepositing chromium directly on an aluminum-containing article selected from the class consisting of articles of aluminum and high aluminum alloys, and wherein the thickness of the chromium deposit ranges from a fraction of a mil to at least 10 mils, which comprises immersing an article to be electroplated in an aqueous alkaline zincate cuprocyanide solution for a time just sufficient to form a zinc-copper immersion coating thereon, removing said article from the solution and dissolving said zinc-copper immersion coating therefrom, immersing the article a second time in the aqueous alkaline zincate cuprocyanide solution for a time just sufficient to form another zinc-copper immersion coating thereon, removing the article from the latter solution, immersing the coated article in a chromic acid chromium plating bath to completely remove the zinc-copper immersion coating by the action of the chromium plating solution, and, immediately after the removal of said coating, electrodepositing chromium on the article, thereby producing a chromium plated article having no intermediate-coating between the chromium and the article.

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**References Cited** in the file of this patent

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 2,091,386 | Viers | Aug. 31, 1937 |
| 2,142,564 | Korpiun | Jan. 3, 1939 |