United States Patent Office 2,888,387
Patented May 26, 1959

2,888,387

ELECTROPLATING

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No Drawing. Application May 14, 1957
Serial No. 658,951

8 Claims. (Cl. 204—33)

The invention relates to electroplating, and is particularly directed to the electrodeposition of chromium directly upon objects or articles of aluminum or aluminum alloys.

The term "aluminum," as hereinafter used in the specification and claims, is intended in a generic sense to include both a commercially pure metal, and alloys of the metal which are predominantly aluminum. Aluminum alloys, whether cast or wrought, are included, and whether of the heat-treatable or non-heat-treatable types.

The problem of plating aluminum with chromium has received a great deal of attention; for it has long been recognized that a surface coating of chromium or aluminum furnishes a highly desirable combination of metals suitable for a wide variety of purposes. It has been difficult, however, to obtain a tightly adherent deposit of chromium over aluminum without incurring painstaking controls and high cost of manufacture. The difficulty apaprently stems from the ever present aluminum oxide film which interferes with normal plating procedures, particularly where it is desired to deposit chromium.

The method in widest commercial use involves the interposition of another metal, such as copper or zinc, between the aluminum object and the subsequent chromium deposit. This method is expensive, and by its very nature involves the use of an additional metal or metals.

The primary object of the present invention is to provide a simple and inexpensive method for plating chromium directly onto aluminum in a manner which does not require close controls, and which affords a resulting product in which the chromium is so tightly adherent to the immediately underlying aluminum that the plated product may withstand high bending, torsional or impact loads without rupture of the bond.

These, and other objects and advantages of the invention will be apparent from the following detailed description.

Generally, the invention involves the anodic treatment of an aluminum article in a solution of hydrochloric acid, followed by cathodic treatment of the article in hydrochloric acid. An aluminum article thus conditioned makes a surface thereof highly receptive to plating with chromium so that a strong and directly adherent deposit of chromium is obtained.

In the preferred form of the invention, the aluminum article is initially cleaned, and degreased, if necessary. Cleaning may be accomplished in any manner well known in the art, as by the use of one of the numerous available proprietary cleaners, which are generally alkaline type emulsions, or by immersion in a 50% nitric acid solution. To degrease, trichloroethylene vapors may be used. After rinsing, and/or air-drying, the aluminum article is made the anode in a solution of hydrochloric acid having a concentration of approximately 0.5 to 1.2 N, the other electrode being carbon. The article is subjected to approximately 3 ampere-minutes per square inch. A voltage range of 5 to 12 volts may be used. Following

the anodic treatment, and with the aluminum article still in the bath, it is made cathodic in the same solution by simply reversing the current. The cathodic treatment of the article is carried out under current density and time conditions of not less than approximately 3 ampere-minutes per square inch, and preferably at 5 ampere-minutes per square inch. Leaving the article in the tank during the cathodic treatment for longer periods does not injure the article, or detract from the effectiveness of the bond after plating. When the aluminum article is removed from the solution, its surface is covered with a dark smut, which is removed by rinsing. A cold water rinse may be sufficient to remove the smut, whereupon the article is ready for plating with chromium. If desired, the article may be immersed in a solution of chromic acid at a temperature of 140 to 160° F. for approximately 3 minutes. The solution may contain approximately 33 ounces of chromic acid per gallon of water. Immersion in the chromic acid solution has been found desirable after a cold water rinse to assure that all smut has been removed.

The aluminum article anodically and cathodically treated as above described is then made the cathode in a chromium plating bath and plated. Any suitable or commercial chromium plating bath may be used. A chromium plating bath which has been found to be particularly suitable is a hard or industrial chromium plating solution containing 33 ounces per gallon of chromic acid and 0.33 ounce per gallon of sulfate in the form of sulfuric acid. The bath is maintained at a temperature of approximately 132° F., and a current density of approximately 3 amperes per square inch is used. This is a standard hard chromium plating bath and given by way of example only, it having been ascertained that any ordinary chromium plating bath is suitable.

After the aluminum article has been chromium plated, it is preferred that the plated article be heat treated. This may be accomplished by placing the article in an oven having a temperature of approximately 400° F. Depending upon the thickness of the aluminum and the amount of chromium deposited thereon, the article may be heat treated for approximately ½ to 4 hours. It has been found that such heat treatment serves to improve the strength of the direct bond between the aluminum and chromium.

While the anodic and cathodic treatments of the aluminum in the same tank as above described minimizes handling and reduces the possibilities of intermediate contamination, and, therefore, is preferred, it is within the scope of the invention to carry out the anodic and cathodic treatments in separate tanks which each contain a hydrochloric acid solution and an inert electrode. In such event, the concentration of the hydrochloric acid in the tank for the anodic treatment may be as dilute as 0.2 N, with a concentration of 0.7 N preferred. It has been found that if the concentration of the hydrochloric acid solution for the anodic treatment is above 1.2 N, the time factor becomes critical, and the possibility of overetching the piece and subsequently producing a plated deposit which is not strongly adherent is greatly increased, unless the process is controlled more closely than is considered desirable. As the normality or concentration of the hydrochloric acid solution is increased, the conductivity is increased, so that a comparatively small increase in the time of treatment represents a substantial part of the current density and time conditions which furnish the best and most uniform results; namely, 3 ampere-minutes per square inch.

For the cathodic treatment in a separate tank, the hydrochloric acid is of a concentration of between approximately 0.5 and 1.2 N, or the same concentration range suitable for both the anodic and cathodic treatments of

the article in the same tank. Whether cathodically treated in a separate tank, or in the same tank as for the anodic treatment, below a concentration of approximately 0.5 N, the resulting adhesion between the aluminum and subsequent chromium deposit is unsatisfactory regardless of the current density used. Above a concentration of approximately 1.2 N, the bond is also unsatisfactory, because the aluminum is unduly attacked. In the cathodic treatment of the aluminum article in the acid, current density and time conditions in excess of 3 ampere-minutes per square inch do not detract from the achievement of a tightly adherent chromium deposit on the aluminum if the concentration of the acid solution is maintained between 0.5 N and 1.2 N. A preferred concentration of the acid for the cathodic treatment is 0.7 N, and the preferred current density and time conditions is not less than 5 ampere-minutes per square inch. Whether the article is anodically and cathodically treated in the same tank or in separate tanks, the hydrochloric acid solution, or solutions, preferably are maintained at room temperature. Amperage is controlling so that any suitable voltage may be used, as for example, between 5 and 12 volts for both anodic and cathodic treatments of the aluminum in the hydrochloric acid.

While it is not necessary to add any oxidizing or reducing agents to the hydrochloric acid solution, or solutions, it will be understood that the addition of such agents is not excluded. In the event of their inclusion, the solution should be the equivalent of a hydrochloric acid solution having a concentration of approximately 0.5 to 1.2 N, or 0.2 to 1.2 N where the anodic treatment of the article is in a separate tank. Such equivalent solution or solutions are contemplated in the definition of the solution concentrations set forth in the claims.

It is believed that the advantages of the process will be apparent from the foregoing detailed description. It also will be apparent that while the invention has been described in its preferred form, changes may be made without departing from the spirit and scope of the invention as sought to be defined in the following claims.

I claim:

1. A process of electroplating an aluminum article directly with chromium comprising making the article the anode in a hydrochloric acid solution having a concentration of approximately 0.2 to 1.2 N and subjecting the article to approximately 3 ampere-minutes per square inch, making the article the cathode in a hydrochloric acid solution having a concentration of approximately 0.5 to 1.2 N and subjecting the article to not less than approximately 3 ampere-minutes per square inch, rinsing, and electroplating the article with chromium.

2. A process as set forth in claim 1, wherein the concentration of the hydrochloric acid solution for both the anodic and cathodic treatments of the article is 0.7 N, and the current density and time conditions for the cathodic treatment in hydrochloric acid is not less than approximately 5 ampere-minutes per square inch.

3. A process of electroplating an aluminum article directly with chromium comprising making the article the anode in a hydrochloric acid solution having a concentration of approximately 0.5 to 1.2 N and subjecting the article to approximately 3 ampere-minutes per square inch, making the article cathodic in the same solution and subjecting the article to not less than 3 ampere-minutes per square inch, rinsing, and electroplating the article with chromium.

4. A process as set forth in claim 3, wherein the concentration of the hydrochloric acid solution is approximately 0.7 N.

5. A process as set forth in claim 3, wherein the current density and time conditions for the cathodic treatment in hydrochloric acid is not less than approximately 5 ampere-minutes per square inch.

6. A process as set forth in claim 3, wherein the concentration of the hydrochloric acid solution is approximately 0.7 N, and the current density and time conditions for the cathodic treatment in hydrochloric acid is not less than approximately 5 ampere-minutes per square inch.

7. A process as set forth in claim 1, wherein the chrominum plated article is heated at approximately 400° F.

8. A process as set forth in claim 3, wherein the chrominum plated article is heated at approximately 400° F.

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