

1

2,847,371

CHROMIUM PLATING ON ALUMINUM

Paul J. Topelian, Newark, N. J., assignor to Tiarco Corporation, Newark, N. J., a corporation of New Jersey

No Drawing. Application June 28, 1955
Serial No. 518,663

10 Claims. (Cl. 204—33)

The invention relates to electroplating and is more particularly concerned with the conditioning or special treatment of aluminum and aluminum alloys preliminary to plating with chromium to provide a tightly adherent bond between the chromium and the aluminum base metal.

The invention is applicable to aluminum and its alloys. "Aluminum," as hereinafter used in the specification and claims is intended in a generic sense to include both the commercially pure metal and alloys of the metal which are predominantly, or contain a substantial quantity of, aluminum. Also, reference to an article of aluminum is intended to include to include a base metal which is entirely of aluminum or some other metal, which is clad with, or has a surface layer of, aluminum.

Much effort has been expended in the endeavor to obtain a tightly adherent deposit of chromium on aluminum. The metal is highly oxidizing in character, and presents an aluminum oxide film which is not receptive to a strongly adherent electrodeposit. Various methods have been suggested for preparing or conditioning an aluminum surface to make it receptive for electroplating.

The process in widest commercial use today for preparing an aluminum surface for plating is the "zinc immersion process." In this process a thin and adherent film of metallic zinc or alloy of zinc replaces the aluminum oxide film. The zinc provides a surface which is more readily plated with other metals than the aluminum. Not all metals, however, may then be simply deposited directly on the zinc surface. Where it is desired to deposit chromium upon the zincated aluminum, special precautions are necessary because the zinc layer is very thin and any treatment which penetrates the zinc layer and attacks the underlying aluminum will result in a poor deposit. When depositing chromium on the zincated surface, the plating must be kept at a low temperature, approximately 68° F., and then only a very thin layer of chromium may be applied. In order to produce thick and hard deposits of chromium a transition must be made to plate at a higher temperature. The zinc immersion process for preparing an aluminum article for chromium plating has procedural limitations and is expensive.

One of the primary objects of the invention is to provide an improved process for plating chromium directly on to aluminum, with the resultant deposit so tightly adherent to the base metal that the finished product is capable of withstanding the rugged and severe conditions encountered in industrial or engineering applications or uses.

It has been proposed to replace the natural aluminum oxide by a relatively thick porous oxide film formed by anodic treatment of the aluminum. This approach to the problem is based on the idea that the plating metal will adhere better to the aluminum through the medium of a controlled oxide film. The results of this method, however, have not afforded maximum adhesion of plated metal to base metal.

2

Special plating solutions have been devised to permit the direct plating on aluminum; however, none of the electrodeposits resulting from such solutions have furnished a truly satisfactory bond of the plate to base metal.

Another process for plating aluminum involves immersing the aluminum in a molten metallic salt bath preliminary to plating. Such process, however, because of the degree of heat involved, frequently has a deleterious affect upon the aluminum, and has proved to be less than satisfactory for many applications.

It has also been proposed to prepare the aluminum for direct plating by preliminarily etching the aluminum, the idea being to develop a keying or mechanical inter-locking between the roughened aluminum surface and the underlying plate. This method is difficult to control, and has not furnished uniformly satisfactory adherence between the plate and the base metal.

In accordance with my invention chromium may be directly plated on to aluminum without impairing the physical properties of the aluminum, while permitting the attainment of a strong bond between the electrodeposit and the underlying aluminum. This is accomplished by conditioning the surface of the aluminum in an aqueous solution containing chromic acid, hydrochloric acid and a chloride of chromium. The addition of chromic acid and chromic chloride to hydrochloric acid seems to buffer or somehow modify the otherwise highly corrosive action of hydrochloric acid on aluminum to condition the surface in a manner which results in an unusually strong bond between the subsequent chromium deposit and the aluminum. The effect of the hydrochloric acid may be additionally tempered by the addition of a small amount of potassium permanganate to the solution. Also, the solution is preferably subjected to electrolytic action, although no current is used when the aluminum article is immersed in the solution.

Describing the invention in greater detail, an aluminum article is degreased and cleaned in accordance with accepted practices. The article may be degreased in trichloroethylene and cleaned with any suitable commercial cleaner such as hot caustic soda. After the alkaline cleaning step, the article is thoroughly rinsed in cold water and then immersed in nitric acid of approximately sixty percent (60%) concentration for a period of ten (10) to fifteen (15) seconds, which turns the surface of the aluminum to a white color. The article is then very thoroughly rinsed, and immersed in the conditioning solution of my invention.

The conditioning solution to achieve firm adherence of electrodeposit to base metal is prepared by dissolving chromic acid in hydrochloric acid, which may be commercial muriatic acid having a concentration of approximately 20° Bé. In terms of a solution of sufficient quantity for commercial use, three and one-quarter (3¼) pounds of chromic acid may be dissolved in five (5) gallons of the hydrochloric acid, or approximately ten (10) ounces per gallon of hydrochloric acid. The chromic acid must be added to the hydrochloric acid in very small amounts at a time, otherwise the reaction will become uncontrollably violent. In any event, strong gassing takes place, and for the amounts stated twenty-four (24) to thirty-six (36) hours should be allowed for the contents of the tank to stop gassing.

Chromic chloride is added to the chromic acid-hydrochloric acid mixture. Metallic chromium in an amount of approximately eight (8) ounces may be partially dissolved in 1000 cc. of hydrochloric acid C. P., and added to the chromic acid-hydrochloric acid mixture.

A small amount of potassium permanganate, approximately one-half (½) ounce, may be added to the hydrochloric acid solution containing the partially dissolved

3

metallic chromium before combining with the chromic acid-hydrochloric acid mixture. As an alternative, chromic chloride crystals in an amount of ten (10) to twenty (20) ounces, and the potassium permanganate, may be added to the chromic acid-hydrochloric acid mixture. Approximately three (3) gallons of water is then added, and the solution is allowed to stand for four (4) to six (6) hours before it is ready to receive aluminum pieces for treatment.

It is preferred to subject the described solution to an electrolytic "cook," and this is done by placing a pair of carbon rods, each having a surface area of approximately twenty (20) square inches in a tank containing the described solution, connecting the rods to the cathode and anode terminals of a rectifier, set at four (4) volts, and electrolyzing the solution for several hours. After cooling to room temperature, the solution is ready for use in the line.

The aluminum article is immersed in the foregoing solution for approximately sixty (60) seconds. In about ten (10) seconds gassing action starts and increases rapidly. When the article is removed from the solution, after about sixty (60) seconds, the entire aluminum surface is literally bubbling, and has a grey appearance. The article is then thoroughly rinsed in cold water, preferably applied under high pressure, and is now ready for chromium plating.

Any commercial chromium plating solution may be used. It is preferred, however, to plate in a hard chromium plating bath containing thirty-three (33) ounces per gallon of chromic acid and 0.33 ounce per gallon of sulfate in the form of sulphuric acid. The bath is maintained at a temperature of approximately 132° F., and a current density of approximately three (3) amperes per square inch is used. The time of plating depends upon the thickness of chromium deposit desired, plating under the conditions stated furnishing a thickness of 0.001 inch per hour. After plating the article is very thoroughly rinsed in cold running water, and then rinsed in hot water and allowed to dry.

After final deposition of the chromium on the aluminum article, it is preferred to heat the plated article at approximately three hundred (300° F.) degrees for one (1) to two (2) hours in a furnace or by immersing the article in hot oil.

Aluminum articles preliminarily treated in the described solution and then chromium plated provides an unusually adherent deposit to the underlying aluminum. The chromium deposit may be subjected to a grinding wheel without displaying any cracking or peeling of the plate. Upon bending the plated article, no cracking or peeling of the plate occurs.

It is believed that the novel process of the present invention, as well as the advantages thereof will be apparent from the foregoing detailed description. It will also be apparent that while the invention has been described in several preferred forms, 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 with chromium comprising immersing the article in an aqueous solution containing chromic acid, hydrochloric acid and chromic chloride, the ingredients being present in the approximate proportions of three (3) pounds of chromic acid, five (5) gallons of hydrochloric acid having a concentration of about 20° Bé. and ten (10) to twenty (20) ounces of chromic chloride, removing the article from the solution after gassing occurs, and electroplating with chromium.

2. A process as set forth in claim 1, wherein the solution is electrolyzed prior to immersion of the aluminum article therein, there being no current applied when the article is immersed.

4

3. A process of electroplating an aluminum article with chromium comprising immersing the article in an aqueous solution containing chromic acid, hydrochloric acid, chromic chloride and potassium permanganate in the approximate proportions of three (3) pounds of chromic acid, five (5) gallons of hydrochloric acid having a concentration of about 20° Bé., ten (10) to twenty (20) ounces of chromic chloride and one-half (½) ounce of potassium permanganate, removing the article from the solution after gassing occurs, and electroplating the article with chromium.

4. A process as set forth in claim 3, wherein the solution is electrolyzed prior to immersion of the aluminum article therein, there being no current applied when the article is immersed.

5. An aqueous solution for preparing an aluminum article for direct electroplating with chromium comprising chromic acid, hydrochloric acid and chromic chloride, the ingredients being present in the approximate proportions of three (3) pounds of chromic acid, five (5) gallons of hydrochloric acid having a concentration of about 20° Bé. and ten (10) to twenty (20) ounces of chromic chloride.

6. An aqueous solution for preparing an aluminum article for direct electroplating with chromium comprising chromic acid, hydrochloric acid, chromic chloride and potassium permanganate in the approximate proportions of three (3) pounds of chromic acid, five (5) gallons of hydrochloric acid having a concentration of about 20° Bé., ten (10) to twenty (20) ounces of chromic chloride and one-half (½) ounce of potassium permanganate.

7. A process of electroplating an aluminum article with chromium comprising immersing the article in an aqueous solution made by mixing chromic acid and hydrochloric acid, in the amounts of approximately ten (10) ounces of chromic acid per gallon of hydrochloric acid, the hydrochloric acid having a concentration of approximately 20° Bé., removing the article from the solution after gassing occurs, rinsing, and electroplating the article with chromium.

8. A process as set forth in claim 7, wherein the solution contains a small amount of chromic chloride.

9. A process of electroplating an aluminum article with chromium comprising immersing the article in an aqueous solution containing chromic acid, hydrochloric acid and chromic chloride, the ingredients being present in the approximate proportions of three (3) pounds of chromic acid, five (5) gallons of hydrochloric acid having a concentration of about 20° Bé. and ten (10) to twenty (20) ounces of chromic chloride, the period of immersion being approximately sixty (60) seconds, rinsing the article in water, and electroplating the article with chromium.

10. A process as set forth in claim 9, wherein the solution contains approximately one-half (½) ounce of potassium permanganate.

References Cited in the file of this patent

UNITED STATES PATENTS

1,789,523	Hahn	Jan. 20, 1931
1,797,357	McCullough et al.	Mar. 24, 1931
1,838,777	McCullough et al.	Dec. 29, 1931
1,988,645	Bowden	Jan. 22, 1935
2,091,386	Viers	Aug. 31, 1937
2,227,469	Thompson et al.	Jan. 7, 1941
2,302,939	De Long	Nov. 24, 1942
2,311,623	Blackum et al.	Feb. 23, 1943
2,357,219	Mott	Aug. 29, 1944
2,428,749	De Long	Oct. 7, 1947

OTHER REFERENCES

A Comprehensive Treatise on Inorganic and Theoretical Chemistry, Mellor, vol. 11, pages 230-231.