FIG. 1

FIG. 2
Pretreatment of Stainless Steel for Electroplating

Richard W. McCabe, Freeport, and Mark J. Johnson, Natrona Heights, Pa., assignees to Allegheny Ludlum Steel Corporation, Pittsburgh, Pa.
Filed Nov. 3, 1969, Ser. No. 873,227
Int. Cl. C23b 5/62

Abstract of the Disclosure

An improved method of electroplating stainless steel with a dissimilar metal. It encompasses an electrolytic treatment which is performed in an alkaline electrolyte at a current density of between 0.025 amp per square inch and 3 amps per square inch with the stainless steel serving as anode and then as cathode.

The present invention relates to a method of electroplating and more particularly to a method of electroplating stainless steel with a dissimilar metal.

Electroplating of dissimilar metals, e.g., chromium, onto ferritic stainless steels has resulted in the formation of a rough, somewhat loosely adherent deposit which has a "frosty" appearance. This deposit frequently referred to as "frosty chrome" is a consequence of the innate manner in which the dissimilar metals are electrodeposited onto the steel. They i.e., the dissimilar metals, adhere to ferritic stainless steels as distinct nodules which increase in size and grow together as plating progresses.

One solution for avoiding "frosty chrome" has been to buff the surface of the stainless steel prior to plating. The amount of buffing necessary is, however, far more excessive than is required to produce a mirror surface. Needless to say, this degree of buffing is both costly and time consuming.

We have developed a method of electroplating stainless steel which enables us to obtain a smooth chromium plate without buffing. It encompasses an electrolytic treatment which is performed in an alkaline electrolyte at a current density of between 0.025 amp per square inch and 3 amps per square inch with the steel serving as anode and then as cathode. The treatment alters the passive stainless steel and affects the mode of deposition by rendering the surface of the steel suitable for the deposition of uniform rather than nodular platings of dissimilar metal.

It is accordingly an object of this invention to provide an improved method of electroplating.

It is a further object of this invention to provide an improved method of electroplating stainless steel with a dissimilar metal.

It is a specific object of this invention to provide an improved method of electroplating ferritic stainless steel with chromium, which eliminates the formation of "frosty chrome." The foregoing and other objects of the invention will be best understood from the following description, reference being had to the accompanying drawings wherein:

Fig. 1 is a photomicrograph at 1800X of a chromium plated A.I.S.I. Type 434 ferritic stainless steel which was plated in accordance with the principles embraced within the invention; and

Fig. 2 is a photomicrograph at 1000X of a chromium plated A.I.S.I. Type 434 ferritic stainless steel which was not plated in accordance with the principles embraced within the invention.

The invention described herein provides an improved method of electroplating which renders the surface of stainless steel suitable for the deposition of uniform rather than nodular platings of dissimilar metal. The method encompasses an electrolytic treatment which precedes the actual plating. It comprises the steps of immersing the stainless steel in an electrolyte, immersing an electrode in the electrolyte, passing as electrical current through the electrolyte with the stainless steel serving as anode and the electrode as cathode, reversing the polarity and passing an electrical current through the electrolyte with the stainless steel serving as cathode and the electrode as anode.

Alkaline solutions with and without chelating agents are used as electrolytes. Solutions containing chelating agents are preferred as they affect the mode of dissimilar metal deposition to a greater degree than do alkaline solutions without chelating agents. A typical alkaline electrolyte is sodium hydroxide and water. Other exemplary alkaline electrolytes are aqueous solutions of potassium hydroxide and calcium hydroxide. A typical chelating agent is ethylenediamine tetracetic acid. Other exemplary chelating agents are thioglycolic acid and citric acid.

Electrical currents which produce current densities of from about 0.025 to about 3 amps per square inch and preferably from about 0.5 to about 1.5 amps per square inch are employed. Current densities below 0.025 amp per square inch are insufficient for rendering the surface of the steel suitable for the deposition of uniform platings of dissimilar metal and current densities in excess of 3 amps per square inch detrimentally affect the surface of the steel. A higher minimum current density of from about 0.25 amp per square inch has been found desirable for the plating of ferritic stainless steels with chromium.

The current is applied for a predetermined period of time with the steel serving as anode and then with the steel serving as cathode. Treatment with the steel being the anode is believed to dissolve surface oxides and possibly some metal while treatment with the steel being the cathode is believed to deposit a type of coating upon the steel which is beneficial for subsequent plating. The period of time in which the steel serves as anode is at least twice as long as the period at which it serves as cathode. If the steel serves as cathode for too long a period, the beneficial coating becomes too thick and turns into a type of detrimental "smut" which adversely affects the mode of plating. The actual period of time in which the steel serves as cathode as well as the actual period of time that it serves as anode, cannot be precisely set forth and must be determined empirically since the periods are dependent upon variables such as the composition of the electrolyte, the current density, the type of stainless steel being plated, the condition of the steel and the type of dissimilar metal. Immersion within the electrolyte is an electrode. It serves as cathode when the stainless steel serves as anode and as anode when the steel serves as cathode. This electrode can be composed of any of the materials which are widely employed as electrode materials for use in electrolytic baths as long as the material is compatible with the electrolyte used. Illustrative materials are platinum, lead, stainless steel and graphite.

The improved electroplating method described herein is not dependent upon the use of particular dissimilar metals or upon the use of any particular plating solutions. Illustrative dissimilar metals are chromium, nickel, copper and brass. Illustrative plating solutions for the illustrative dissimilar metals respectively, comprise aqueous solutions of: nickel sulphate, nickel chloride and boric acid; chromic acid and sulphuric acid; copper cyanide, sodium cyanide and sodium carbonate; and copper cyanide, zinc cyanide, sodium cyanide and sodium carbonate.

The following examples are exemplary of several embodiments of the invention.

Three stainless steel samples were electroplated in accordance with the invention described herein. Samples I and II were A.I.S.I. Type 434 ferritic stainless steels and
sample III was A.I.S.I. Type 301 austenitic stainless steel. All three samples were immersed in aqueous solutions of 4.5% sodium hydroxide and 0.5% ethylenediamine tetraacetic acid, which were at a temperature of 170° F. The stainless samples were made the anodes and electrical currents sufficient to produce current densities of 1 amp per square inch were passed through the electrolyte for 40 seconds. Polarities were then reversed and the stainless samples were made the cathodes. Electrical currents sufficient to produce current densities of 1 amp per square inch were thereafter passed through the electrolyte for 10 seconds.

Sample I was then rinsed and placed directly into a bright chromium plating solution made from a CR-110 chromium plating mix sold by M & T Chemicals, Inc. of Rahway, N.J. The plating solution was at a temperature of 130° F. A current density of 0.75 amp per square inch was maintained for a 4 minute period. The samples were then removed from the solution.

Samples II and III were rinsed and placed directly into the nickel plating solutions made from 15 gms. of nickel chloride, 15 cc. hydrochloric acid and enough water to produce 1 liter of solution. The plating solutions were at room temperature. A current density of 0.5 amp per square inch was maintained for a 2 minute period. The samples were then removed from the solution.

All of the plated samples exhibited a smooth, uniform tightly adherent plate. Sample I had a smooth, reflective and bright plate and was free of the nodules and "frosty chrome" which was evident on chromium plated ferritic samples which were not electroplated in accordance with the teachings of the invention.

A study of FIGS. 1 and 2 reveals the difference between plated ferritic steels which were and which were not plated in accordance with the principles embraced within the invention. FIG. 1 is a photomicrograph at 1800X of a chromium plated A.I.S.I. Type 434 ferritic stainless steel which was plated in accordance with the invention following the processing used to plate sample I. FIG. 2 is a photomicrograph at 1000X of a chromium plated A.I.S.I. Type 434 ferritic stainless steel which was placed into the same bright chromium plating solution as was sample I, but which was not electrolytically treated prior to immersion in the plating solution as was sample I. Note the difference in appearance between the specimens shown in the figures. FIG. 1 exhibits a smooth, reflective, bright plate, whereas FIG. 2 exhibits a nodular, rough, non-reflective, frosty plate.

It will be apparent to those skilled in the art that the novel principles of the invention disclosed herein in connection with specific examples thereof, will suggest various other modifications and applications of the same. It is accordingly desired that in construing the breadth of the appended claims they shall not be limited to the specific examples of the invention described herein.

We claim:

1. An improved method of electroplating ferritic stainless steel with chromium, comprising: treating ferritic stainless steel prior to plating, said treating comprising the steps of immersing said stainless steel in an alkaline electrolyte, immersing an electrode in said electrolyte, passing an electrical current which produces a current density of from about 0.25 amp per square inch to about 3.0 amps per square inch through said electrolyte with the stainless steel serving as anode and the electrode as cathode, reversing the polarity and passing an electrical current which produces a current density of from about 0.25 amp per square inch to about 3.0 amps per square inch through said electrolyte with the stainless steel serving as cathode and the electrode as anode; the period of time said stainless steel serves as an anode being at least twice the period of time said stainless steel serves as a cathode; and electroplating said stainless steel with chromium.

2. A method according to claim 1 wherein said electrolyte contains a chelating agent.

3. A method according to claim 2 wherein said electrolyte contains sodium hydroxide and ethylenediamine tetraacetic acid.

4. A method according to claim 1 wherein said electrical currents produce current densities of from about 0.5 amp per square inch to about 1.5 amps per square inch.

5. A method according to claim 4 wherein said electrolyte contains a chelating agent.

References Cited

UNITED STATES PATENTS

1,909,149 5/1933 Hitter 204—34
1,954,473 4/1934 Dunn 204—34
2,915,444 12/1959 Meyer 204—34

OTHER REFERENCES


JOHN H. MACK, Primary Examiner
WILLIAM I. SOLOMON, Assistant Examiner

U.S. Cl. X.R.

204—34