PROCESS FOR PREPARING A PLATINUM COATED NICKEL-IRON-CHROMIUM ALLOY ARTICLE

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ABSTRACT OF THE DISCLOSURE

There is disclosed a process for coating the surface of a nickel-chromium-iron alloy with platinum. The surface of the alloy is first cleaned to remove all oxides and foreign material and then heated to a temperature of about 500°F. Molten platinum is then sprayed onto the surface at a sufficiently elevated velocity to rupture any oxides formed on the surface of the base alloy and to metallurgically bond the platinum to the alloy. In this way a tenacious bond between the alloy and platinum is achieved.

RELATED CASES

This is a continuation-in-part of copending U.S. patent application Ser. No. 500,349, filed Oct. 21, 1965, now abandoned.

THE INVENTION

The invention relates to the coating of a base metal with metal for the purpose of protecting the base metal against the deleterious effects of atmospheres, such as volatile acid, in contact therewith. More particularly, this invention relates to a process for preparing a corrosion resistant metal article comprising a base metal and a platinum coating which is metallurgically bonded to the base metal.

In the chemical industry, many corrosive atmospheres are present within which metal parts must be located. One metal which has exceptionally good corrosion and/or heat resistance is platinum. However, platinum is quite expensive and, therefore, it has been desirable to use as little platinum as is necessary to provide sufficient protection to metal parts which may be subjected to high temperatures and/or corrosive atmospheres. Many iron or nickel base alloys exhibit sufficient thermal resistance so as to be capable of use at fairly high temperatures; however, in a corrosive atmosphere these metals oxidize and corrode quickly.

It has been the practice in the past to mechanically clad such base metals with platinum sheeting. However, one serious drawback is that the thermal expansion characteristics of platinum and the base metals are such that there is a tendency for the platinum to buckle and warp under temperatures in the 2000°F. and above range. Furthermore, the mechanical cladding of platinum to a base metal is time consuming and necessitates the use of relatively thick platinum sheets. A further problem encountered in the cladding procedure is that it is extremely difficult to prevent the formation of "pin holes" particularly in the welding areas. The formation of "pin holes" renders the clad article unsuitable for many uses in corrosive atmospheres. As would be expected, there is no metallurgical bond produced between the base metal and the platinum when the usual cladding techniques are employ

In accordance with this invention, there is provided a process for bonding platinum or an alloy thereof to the surface of an iron or nickel base alloy such as Inconel (about 78% nickel, 13% chromium, 6% iron and less than 1% each of manganese, silicon, and copper) or Nichrome (about 15-16% chromium, 59-62% nickel, and 24% iron), which process comprises cleaning the surface of the base alloy so as to remove all traces of any adherent oxides or other foreign matter therefrom, heating the cleaned surface to a temperature sufficient to cause molten platinum or platinum alloy applied thereto to spread over the base surface without instantly freezing, and then spraying molten platinum or platinum alloy to the heated base alloy at an elevated velocity sufficient to metallurgically bond the platinum or platinum alloy to the surface.

As used herein platinum alloy is defined as including any suitable platinum alloy containing at least 30 percent by weight platinum.

In order to ensure that the base metal remains clean and substantially oxide free at the surface, it is necessary to apply the molten platinum, e.g., by flame-spray or plasma-jet spray, onto the cleaned base metal within a relatively short period of time after cleaning so that any oxide which may form on the base metal in the interval between cleaning and spraying will be held to a minimum or at least so that the oxide will be of a dispersed character.

Also, in order to spray platinum or platinum-rhodium alloys onto the base metal so that the platinum forms a continuous, non-porous layer, it is necessary that the clean base metal should be at an elevated temperature such that the molten metal droplets in the spray will not be chilled too abruptly upon contact with the base metal surface. With this in view, it has been found that a temperature of about 300°F. to 800°F., typically about 500°F., is most suitable, from the standpoint of not producing any appreciable build-up of an oxide on the base metal surface prior to spray coating. Obviously, other temperatures may be used and the particular temperature selected is a balance between a sufficiently high temperature to prevent too great a temperature differential between the platinum droplets and base metal surface, and low enough temperature so that no substantial oxidation of the base metal surface occurs. The temperature chosen is also temperature-dependent from the standpoint that if the coating step is effected quickly, after cleaning and heating, there will not have been sufficient time for a heavy oxide to be formed.

A further consideration from the viewpoint of producing a "pin-hole" free coating is the necessity of propelling the droplets of molten aluminum at sufficient velocity so that any slight oxide which may be present on the base metal will be ruptured by the impact of the spray. It has been found that a velocity of between 100 and 200 ft. per second is sufficient to accomplish this result and that a true metallurgical bond is produced at the interface of the platinum and the base metal. As is well known, the production of a metallurgical bond involves the physical interdissipation of the molecules of the two metals such that an interchange of electrons occurs. With this type of bond produced, the platinum or platinum alloy will tenaciously adhere to the base metal, for example, Inconel.

As an indication of the bond produced, a piece of Inconel pipe was cleaned with emery paper, preheated to about 500°F., platinum-spray coated, and a section of the coated pipe heated to 2500°F. for 15 minutes. This piece was then water quenched twice from 1000°F. and three times from 1200°F. and the bond remained intact. As an additional test, a section of Inconel pipe, of 2-inch diameter, coated in accordance with this invention, was bent into a nearly flattened, appearing section without producing any micro-cracks. Thus the bond, formed by the process of this invention, between the base metal and platinum coating was tenacious and of the metallurgical type. Furthermore, the coating was "pin-hole" free as indicated by the fact that the Inconel pipe was plugged at
its ends and then immersed in concentrated nitric acid for a 24-hour period at room temperature without discoloration of the acid as it would have been if the Inconel were attacked and no hydrogen evolved from the acid bath.

I claim:

1. A process for coating the surface of a nickel or iron base alloy with a tenaciously adhering platinum or platinum alloy coating which is continuous and free of any porosity, which process comprises cleaning the surface of the base alloy so as to remove all traces of any adherent oxides and foreign matter therefrom, heating the cleaned surface to a temperature sufficient to cause molten platinum or platinum alloy applied thereto to spread over the base surface without instantly freezing, and then spraying molten platinum or platinum alloy onto the heated base alloy at a velocity sufficient to rupture any oxides formed on the surface of the base alloy and to metallurgically bond the platinum or platinum alloy to the surface.

2. The process of claim 1 wherein the base alloy is a nickel-chromium-iron alloy.

3. The process of claim 1 wherein the cleaned base alloy is heated to a temperature of about 300° F. to about 800° F.

4. The process of claim 1 wherein the molten platinum, or platinum alloy is sprayed at a velocity of about 100 to 200 feet per second.

5. The process of claim 1 wherein the cleaned base alloy is heated to a temperature of about 500° F.

6. The process of claim 1 wherein the platinum alloy contains at least 30 percent by weight platinum.

7. A process for coating a nickel or iron base alloy with platinum or platinum alloy which comprises cleaning the surface of the base alloy so as to remove all oxides and foreign material therefrom, heating the base alloy to about 300° F. to 800° F., and then spraying molten platinum or platinum alloy containing at least 30 percent by weight platinum directly onto the heated base alloy, said molten platinum or platinum alloy being sprayed at an elevated velocity sufficient to rupture any oxides formed on the surface of the heated base alloy.

8. The process of claim 7 wherein the base alloy is a nickel-chromium-iron alloy.

9. The process of claim 8 wherein the base alloy is heated to about 500° F.

References Cited

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