PROCESS FOR BONDING PLATINUM ONTO A BASE METAL

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ABSTRACT OF THE DISCLOSURE

There is disclosed a process of metallurgically bonding a platinum coating to a base metal by applying to the base metal an easily reduced metal which will not oxidize and thereafter applying molten platinum in droplet form onto the reduced metal. The contemplated base metals include iron or nickel base alloys such as Inconel, Nichrome, and the like. The contemplated reduced metal is gold, silver, or copper. The application of the molten platinum in droplet form may be by a flame-spray or plasma-jet spray technique.

RELATED CASES

This is a division of copending U.S. patent application Ser. No. 472,417, filed July 16,1965, now Pat. No. 3,432,278.

THE INVENTION

This invention relates generally to the art of coating metal articles and in particular is concerned with a process for metallurgically bonding a platinum coating to a 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.

In recent times it has been the practice to flame-spray metals with coatings of other types of metals. However, in these situations particularly when an attempt is made to flame-spray platinum over Inconel or other iron or nickel base alloys, the flame used in spraying the metal will oxidize the base metal, thus producing a poor bond between the platinum and the base metal.

With the foregoing in mind, this invention comprises a process for metallurgically bonding platinum to base metals.

More particularly, this invention relates to a process for metallurgically bonding platinum to a base metal by utilizing an easily reduced metal as an intermediate plated-on layer.

The invention and the advantages thereof will be apparent from the following description taken in conjunction with the annexed sheet of drawings, wherein:

FIG. 1 is a perspective view of a metal pipe having platinum applied thereto by the improved process; and,

FIG. 2 is a block diagram illustrating the successive steps of the improved process.

In accordance with this invention, it has been discovered that molten platinum can be metallurgically bonded to base metals such as iron or nickel base alloys such as a chrome-nickel steel sold under the trade name Inconel, by International Nickel Co. Nichrome and the like without the production of "pin holes" if the base metal is first plated with a thin, e.g., .00005 inch, layer of gold or other noble or easily reduced metal which will not oxidize at elevated temperatures, e.g., at the temperature of the molten platinum; that is, a noble metal which can be reduced and which will not oxidize during the flame-spraying of platinum thereon. After the gold or other easily reduced metal is plated on the base metal, a flame-spray or plasma-jet spray technique may be utilized to apply the platinum in molten droplet form to the gold to a thickness of at least about .015 inch. Whether the platinum is applied by flame-spray or plasma-jet spray technique is immaterial so long as there is a deposition of molten platinum in droplet form onto the (gold) plated base metal.

After the spray cladding, it is desirable to stress relieve and sinter the composite structure, for example by heating to 1800°F for two hours for an Inconel-gold-platinum combination. In this particular arrangement the gold serves two purposes: (1) it provides a non-oxidized surface for the platinum; and (2) it also serves as a brazing metal in that the platinum diffuses into the gold and the gold diffuses into the Inconel. Thus a metallurgical bond is established between the Inconel and the platinum. The surface of the base metal may be roughened prior to the gold plating so as to avoid any possibility of the applied platinum separating from the base metal during subsequent sintering. Furthermore, it has been found desirable and is preferred that the plated base metal article be preheated to a temperature of approximately 1200°F. and that the applying of the molten droplets of platinum be carried out while the plated article is hot. By this technique, the impingement and impact of the platinum droplets, as such strike the intermediate layer of easily reduced metal, will assume a more flattened contour since there is a somewhat more effective diffusion of the molten platinum particles and the article to be clad. In this manner a more tenacious and better metallurgical bond will be provided, and the formation of pin holes or random spots where the platinum, even if sprayed with several layers, might provide an intrusion or passage through the platinum through the gold, is prevented.

As can be seen when referring to FIG. 1 of the drawing, the base metal 10, such as Inconel, is plated with a layer of pure gold 11 and then flame-sprayed or plasma-jet sprayed with platinum to form the coating or cladding 12.

While gold has been disclosed as the preferred metal which is plated to the clean iron or nickel base alloy, it is also possible to use copper in place of gold. However, when copper is used as the metal plated to the iron or nickel base alloy, it is necessary to use a reducing gas shield over the plated article prior to the spraying of platinum thereon in order to ensure that the copper does not have an oxide layer or surface when the platinum is applied thereto. Copper does exhibit the property that when it is being flame-sprayed, for example in a platinum flame-spraying system, it tends to lose its oxide coating and appear as a bright metal under the extreme heats involved in the flame-spraying. Thus, there is the tendency of the copper to clean itself of oxide during the flame-spraying of platinum thereon.

A third plating material which may be used in accordance with the invention is silver. Silver may be plated...
over the Inconel for example, in a relatively thin layer; however, it would be necessary to heat the silver-plated article to a temperature sufficient to decompose all the silver oxide on the surface of the silver, for example at 1200° F. This heating will effectively clean the silver and permit the flame-spraying of platinum thereon, with the result that the platinum will adhere and form a metallurgical bond with the silver and the silver in turn would metallurgically bond with the Inconel to produce a metallurgically bonded article when sintered.

As previously described, the base metal may be roughened prior to the plating of the gold, copper or silver. However, this roughening may not be necessary, particularly in the situation where the plating is to occur on the outside surface, for example of a piece of pipe, since the sprayed platinum will shrink tightly around the base metal pipe. In those situations where the platinum is to be put on the inside of an article such as a pipe, either roughening, preheating or both would be required in order to keep the sprayed platinum from pulling loose.

In all instances the step of heating to stress relieve and sinter the composite article is desirable in order to ensure the production of a good metallurgical bond of the platinum to the substrate.

Having described the best mode of carrying out the invention, the scope of the invention should not be limited except as required by the scope of the appended claims.

I claim:

1. A process for metallurgically bonding platinum to a base metal of iron, nickel, or alloys thereof which comprises plating the base metal with a layer of easily reduced metal selected from copper, silver, or gold and then depositing platinum in molten droplet form by flame-spray or plasma-jet-spray into the plated base metal whereby the platinum is metallurgically bonded thereto, said metallurgically bonded platinum having a thickness of at least .007 inch.

2. The process of claim 1 wherein the base metal is selected from iron or iron base alloys.

3. The process of claim 1 wherein the base metal is selected from nickel or nickel base alloys.

4. The process of claim 1 wherein the easily reduced metal is copper which is maintained oxide free and wherein the platinum is applied in a reducing gas atmosphere.

5. The process of claim 1 wherein the easily reduced metal is silver and wherein the composite structure of silver and base metal is heated to and maintained at a temperature of about 1200° F. so as to free the silver surface thereof from oxides before the molten platinum is applied thereto.

6. The process of claim 1 wherein the platinum is applied to a thickness of about .007 to about .015 inch.

7. The process of claim 6 wherein the base metal is a chrome-nickel steel.

8. The process of claim 1 wherein the composite structure of platinum, reduced metal, and base metal is heated to an elevated temperature for a period of time sufficient to stress relieve and sinter the structure.

9. The process of claim 8 wherein the base metal is a chrome-nickel steel, the reduced metal is gold, and the structure is heated at approximately 1800° F. for about two hours.

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