United States Patent Office 3,066,042 Patented Nov. 27, 1962

3,066,042

METHOD OF COATING METAL

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No Drawing. Filed Nov. 27, 1959, Ser. No. 855,508
1 Claim. (Cl. 117—65.2)

The present invention deals with a method of coating metal and more particularly with a method of coating refractory metal with a platinum-group metal.

It is well known that molybdenum at high temperatures has high strength properties which makes it desirable for high temperature, high stress applications, e.g. for jet engine turbine blades, glass melting apparatus, and other structures for use under high temperatures.

However, molybdenum, as such, cannot be advantageously utilized because of its high rate of oxidation at high temperatures.

In order to protect molybdenum from oxidation at high temperatures, platinum is generally used as a cladding metal and is applied to the molybdenum by bonding a strip or sheet of platinum to the molybdenum or by bonding a tube of platinum onto a core of molybdenum wire or rod to form a composite material. Otherwise, the molybdenum is provided with a fitted platinum sheath and the structure formed therefrom is welded only at the structural joints. The composite material is unsatisfactory for many applications because of the exposure of the molybdenum at the edges of the strip, sheet or rod. The sheathed molybdenum is unsatisfactory because there is no strong bond between the molybdenum and platinum, and the platinum is subject to fracture under stresses with the subsequent failure of the molybdenum.

While the spraying of a thin layer of platinum metal onto molybdenum has been considered, the sprayed layer coating is porous and does not adequately protect the molybdenum.

The present invention relates to the spraying of platinum or other platinum group metals such as palladium and rhodium or alloys thereof onto a molybdenum body, or a body of other refractory metal, e.g. tantalum, tungsten, titanium, in a manner whereby the platinum group metal completely covers the body with a strong mechanical and metallurgical bond therebetween and otherwise provides a suitable protective cladding for use at elevated temperatures.

A simplified flow diagram of the method of the invention is as follows:

Cleaning refractory metal plate

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Spraying molten platinum on cleaned plate to form a first coating

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Shot peening the platinum coating

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Heat treating shot peened coating

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Spraying a second platinum coating on first coating

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Shot peening second platinum coating

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Heat treating shot peened second coating

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Repeating spraying, shot peening and heat treating for subsequent coatings

It is an object of the invention to provide a method of cladding a refractory body with a platinum group metal.

It is another object of the invention to provide a method of applying a plurality of sprayed layers of a platinum group metal onto a refractory body whereby the body is adequately protected against oxidation at high temperatures.

Other objects and advantages of the invention will become apparent from the description hereinafter following.

In accordance with the invention, a sheet, strip, rod, bar or other structure composed of molybdenum is first cleaned by well known chemical cleaning or etching methods after which molten platinum is sprayed onto the molybdenum by the known metallizing gun spray method to form a thin layer coating on the molybdenum. Thereafter, the coating is preferably plastically deformed, e.g. the coating is shot peened, by known shot peening procedure, whereby the entire layer is substantially plastically deformed sufficiently to condition the layer for improved solid diffusion of the layer by a subsequent heat treating; and to otherwise place the layer and the molybdenum in more intimate contact with each other. Thereafter, the coated molybdenum is heat treated, i.e. annealed, in a reducing atmosphere, e.g. in dry hydrogen, at a temperature of from 600° C. to 1400° C. for about one to ten hours depending upon the temperature employed, whereby the consequent solid diffusion of the layer eliminates the pores inherent in the sprayed platinum layer. After the aforesaid treatment of the first sprayed platinum layer, the coated molybdenum is not sufficiently protected for high temperature application. Therefore, the spraying, peening and heat treating are repeated whereby a sufficiently thick protective coating is provided by the spraying in layers with intermediate peening and heat treatment. The process is repeated until the coating has the desired thickness, i.e. from tenths of a thousandth of an inch to any thickness required. Desired thickness is determined by the life expectancy of the end product. It has been discovered that while substantially thick spray coatings may be provided by continuous spraying, such continuous coatings are inferior to the coatings provided by the aforesaid method of the invention and otherwise, the intermediate shot peening not only improves the solid diffusion of the layers under the heat treatment, but also provides for a stronger mechanical and metallurgical bond between the platinum layer and the molybdenum.

Example

A surface of a 2" x 2" molybdenum plate .025" in thickness was cleaned and etched and was sprayed with molten platinum and provided with a platinum layer 0.003" in thickness. The coated surface was shot peened and then annealed in dry hydrogen for one hour at a temperature of 1000° C. The coated plate was cooled in air and the same operation repeated four times until a layer aprpoximately 0.012" in thickness was built up on the molybdenum plate. The layer was found to be substantially non-porous.

While shot peening is specifically referred to, the coating may be plastically deformed by other methods such as pressing or rolling.

While specific embodiments of the invention are described, modifications are contemplated within the scope of the appended claims:

What is claimed is:

The method of coating a refractory metal body composed of a metal selected from the group consisting of molybdenum, tantalum, tungsten and titanium, comprising cleaning a surface of the body, spraying a molten platinum group metal on the cleaned surface in the form

of a thin coat, shot peening the coating, heat treating the shot peened coating at a temperature from 600° C. to 1400° C. to promote solid diffusion of the coating, and alternately continuing the spraying, shot peening and heat treating until a sufficiently thick coating of platinum group metal is built up on the metal body.

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