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2,873,208

DEPOSITION OF REFRACTORY METALS AND ALLOYS THEREOF

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No Drawing. Application September 26, 1955
Serial No. 536,728

Claims priority, application Great Britain
September 27, 1954

5 Claims. (Cl. 117—50)

This invention relates to the deposition of refractory metals and alloys thereof and has for its object to provide an improved method for the production of coherent layers of tungsten or molybdenum or alloys of tungsten and molybdenum.

According to the present invention, the material of the layer to be produced is disposed in the vicinity of the article on which the layer is to be produced and is heated to a high temperature exceeding 1900° C. but below its melting point, the article itself being at a temperature within the range 500° C. to 1400° C. and the space between said material and said article being filled with an atmosphere containing hydrogen and water vapour and/or oxygen. These coherent layers are adherent to metals such as steel so that the invention provides a method for applying protective coatings to such metals. The method according to the invention can also be utilized for the production of tubes, sheets or foils of tungsten, molybdenum, or alloys thereof, by depositing a layer on a rod or tube of another metal and then removing the other metal, e. g. by dissolving it chemically. The resulting tube can be used as such or can be opened to form a sheet or foil. The coherent layers produced in accordance with the present invention are stronger than those produced by hitherto known methods so that the mechanical properties of the tubes, foils and sheets are correspondingly enhanced. The present method can also be applied to the production of shaped pieces of tungsten, molybdenum or alloys thereof, which would otherwise be difficult to fabricate.

In carrying out the present invention, it is preferred that the material of the layer to be produced is heated to a temperature in the range 2200° C. to 3000° C., and that the material to be coated should be heated to a temperature lying within the range 700° C. to 1000° C.

The atmosphere in which the deposition is performed must contain hydrogen and water vapour. The rate of deposition is affected by the overall gas pressure and the relative proportions. If desired, the atmosphere may contain, in addition, one or more inert gases such as nitrogen or the rare gases. Although effectively the atmosphere must consist of or contain hydrogen and water vapour, the result may be achieved by admixing oxygen with the hydrogen, as when the mixture is in contact with the hot material which is to be deposited it will react as water.

For the deposition of tungsten, a tungsten source at 2200° C. is placed in the near vicinity of a steel surface which is to be coated. This surface is maintained at 800° C. and the atmosphere between tungsten source and this surface consists of hydrogen at atmospheric pressure, or slightly above, saturated with water vapour at 40° C. to 100° C. It is believed that the water vapour attacks the tungsten source to produce a volatile tungsten

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compound which is transported to the surface to be coated. At this surface, there is a reduction of the volatile compound resulting in the deposition of tungsten and the liberation of water vapour. In a closed system, this water vapour can re-attack the tungsten source so that the process can continue in a cyclic fashion.

The deposition of tungsten can be carried out in several ways:

(1) Small objects may be plated in a closed system in which the tungsten source is placed in the vicinity of the article to be plated under, for example, a bell jar containing hydrogen and a source of water vapour.

(2) Tubes may be internally coated by making them the containing vessel. A tungsten filament is supported down the middle of the tube which is heated in a furnace. The gas atmosphere may be static or flowing.

(3) Methods 1 and 2 can be modified, by arranging for the tungsten filament to move, thus exposing a fresh surface and preventing the growth of hot spots due to the wire becoming too thin.

(4) A preferred method is to spray the specimen with the gases produced by passing wet hydrogen over a hot tungsten filament.

Certain metals and alloys are attacked by the wet hydrogen to give an oxide layer which would prevent good adhesion of the deposit. This is the case, for example, with chromium-rich steels. To overcome this, the specimen is given a preliminary deposit of an inert metal by conventional methods, for instance a thin layer of nickel may be deposited by electrolysis.

Various modifications are possible in the process as outlined. Thus, for example, the water vapour can be supplied by means of an atomiser, mixed gas (nitrogen and hydrogen) may be used instead of pure hydrogen, and/or the specimen being coated may be surrounded by a "blanket" of inert gas to minimize oxidation.

Where in the foregoing there is reference to tungsten, it will be apparent that the source will be of molybdenum when molybdenum is to be deposited, whereas if it is desired to deposit a tungsten-molybdenum alloy use will be made of a corresponding alloy as single source or of separate sources of tungsten and molybdenum respectively.

What is claimed is:

1. A process for the deposition of a layer of at least one metal selected from the group consisting of tungsten and molybdenum on a base article formed of a material other than said metal and capable of resisting temperatures at least as high as those used in this process comprising the steps, heating a source of one of said metals to a temperature higher than about 1900° C. but below the melting point of said metal, heating the base article to a temperature of about 500° to 1400° C., bringing said heated source into the vicinity of, but not in contact with, said base article, and filling the space between said source and said article with an atmosphere containing hydrogen and water vapor.

2. The process of claim 1 in which the source is heated to a temperature between 2200° C. and 3000° C. and the base article is heated to a temperature between 700° C. and 1000° C.

3. The process of claim 1 in which the atmosphere between the base article and source consists of hydrogen at about atmospheric pressure saturated with water vapor at a temperature between about 40° C. to 100° C.

4. The process of claim 1 in which the source consists of tungsten.

5. The process of claim 1 in which the source consists of molybdenum.

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