United States Patent Office 3,813,258
Patented May 28, 1974

3,813,258

METHOD FOR EVAPORATING SILVER ON TITANIUM AND ITS ALLOYS

Helmut Pieper, Bremen, and Gustav Tober, Delmenhorst, Germany, assignors to Vereinigte Flugtechnische Werke-Fokker Gesellschaft mit beschrankter Haftung, Bremen, Germany

No Drawing. Filed Apr. 27, 1972, Ser. No. 247,952
Int. Cl. C23c *13/02*
U.S. Cl. 117—71 M 3 Claims

ABSTRACT OF THE DISCLOSURE

Method of providing silver layers of high adhesive strength on titanium or titanium alloy surfaces, in that purest titanium is evaporated onto a titanium or titanium alloy surface; and subsequently nickel, copper and finally silver are evaporated thereon.

BACKGROUND OF THE INVENTION

The present invention relates to a method for evaporating silver onto titanium or a titanium alloy using an intermediate layer for enhancing adhesive strength of the silver. Titanium alloys with a predominant titanium content as they are available have about 73% Ti or more.

It is known generally for providing a silver coating on metal or even on non-metallic surfaces by means of evaporation. However, the deposited silver does not adhere sufficiently in many cases, particularly when the silver is directly deposited on the substrate. In order to obviate this deficiency, it has been suggested to provide an intermediate layer between substrate and silver coating so as to improve adhesive strength. Particularly it is known, for example, to provide a substrate, to deposit chromium and subsequently copper which serves as substrate proper for the silver. This method is used, for example, for making the reflective surface in headlights for cars. It is also known to provide for particular mixtures as substance that is to serve as intermediate layer; this depends to a considerable extent on the material of the substrate.

All these known methods and the several known sequences of strata are not sufficient or suitable for adequately improving the adhesive strength of an evaporated silver coating when the main substrate is titanium or one of its alloys.

DESCRIPTION OF THE INVENTION

In accordance with the preferred embodiment of the present invention, the adhesive strength of a silver coating can be improved considerably, if first a layer of purest titanium is evaporated onto the titanium or titanium alloy substrate, followed by evaporating layers of nickel, copper and, finally, silver. The boundary zones between the several starta do not have to be sharply defined; rather mixed layers can provide for gradual transition from one layer to the next one through a mixed metal zone.

The layer thickness in each case is preferably larger than about 100 nanometers and the individual layers need not be thicker than 300 nanometers. If necessary, the outer silver layer may be re-enforced through electroplating.

Evaporating silver on a titanium or a titanium alloy part was found to be an advantageous feature if the part may enter into frictional engagement with a steel part. The silver coating prevents friction corrosion of the titanium upon contact with steel as such frictional contact leads rapidly to corrosive destruction of the titanium surface.

A more detailed example of practicing the preferred embodiment of the invention is explained next.

A metallic, rather rough surface of a part made of titanium is first titanium pickled and then subjected to a

vacuum with 10^{-2} millimeter mercury of an argon atmosphere. Subsequent ion etching removes any oxide layer whereby, however, the titanium substrate is heated up to 350° to 400° C. Next, the pressure in the process chamber is lowered to 10^{-6} mm. Hg, and now purest titanium is evaporated until a strata thickness of about 200 nanometers on the titanium surface has been obtained. Purest titanium has 0.1% or less impurities. The titanium is preferably deposited under utilization of an electron beam gun.

Next, nickel is evaporated to obtain a nickel layer on the pure titanium layer at about 100 nanometer thickness, followed by depositing a copper layer of about 200 to 250 nanometer thickness. Preferably, the method is carried out by gradually switching from nickel to copper in the evaporation, so that a nickel-copper strata results as a transitional layer between nickel and copper proper. Finally, silver is evaporated onto the copper. Again, it is preferred to provide for a gradual transition from copper to silver, to obtain a mixed copper-silver layer in the boundary region as between pure copper and pure silver strata.

The layer dimensions mentioned above assume a rather coarse titanium substrate surface, such as resulting from cutting. However, the titanium surface may be finished first in which case the several layers as evaporated may well be made thinner.

It was found that the silver coating so produced has very high adhesive strength. This property is deemed to result from the providing of a very pure titanium layer as intermediate strata. Other intermediate layers did not produce this result. Apparently, the titanium layer as evaporated provides for a largely undisturbed crystal lattice configuration, and nickel adheres very well to that kind of layer structure. The other layers adhere to each other without difficulties.

The invention is not limited to the embodiments described above but all changes and modifications thereof not constituting departures from the spirit and scope of the invention are intended to be included.

We claim:

1. Method of coating titanium or titanium alloys with a silver layer of high adhesive strength for adhesion to the titanium or titanium alloy surfaces as coated, comprising the steps of:

evaporating high purity titanium onto a titanium or titanium alloy surface; and

evaporating subsequently and in the following sequence: nickel, copper and finally silver respectively for obtaining a nickel layer on the titanium layer as produced, a copper layer on the nickel layer and a silver layer on the copper layer.

2. Method as in claim 1, wherein the silver layer subate layers are provided at thickness in the range of about 100 to 300 nanometers.

3. Method as in claim 1, wherein the silver layer subsequently strengthed by additional galvanical silver plating.

References Cited

UNITED STATES PATENTS

3,558,445	1/1971	Rix et al.	29—198
3,297,552	1/1967	Gisser et al.	204—46
3,268,306	8/1966	Jefferys	29—198
3,074,829	1/1963	Novy et al.	29—198
2,900,715	8/1959	Milnes	117—71 M
2,674,542	4/1954	Alexander	117—131

CHARLES E. VAN HORN, Primary Examiner

M. W. BALL, Assistant Examiner

U.S. Cl. X.R.

29—198, 199; 117—107, 131; 204—38 B