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ABSTRACTS

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Poster

Friday, 17th Sep.

Fri-P

1. PROPERTIES OF SURFACE LAYERS ON THE TI-6AL-3MO-2CR TITANIUM ALLOY PRODUCED UNDER GLOW DISCHARGE CONDITIONS

A. Fleszar*, T. Wierzchoń*, Sun Kyu Kim**
* Warsaw University of Technology, Faculty of Materials Science and Engineering, Narbutta 85, 02-542 Warsaw, Poland.
** School of Materials Science and Engineering, University of Ulsan, Ulsan, Kyung Nam, 680-749 South Korea

The recent rapid progress in surface treatment techniques dictates that titanium alloys should have an improved resistance to frictional wear without any loss of their high corrosion resistance. These requirements can be satisfied by producing surface layers of specified microstructure and phase composition.

The paper presents the results of examinations of structure and properties of the surface layers formed on the Ti-6Al-3Mo-2Cr titanium alloy subjected to glow discharge assisted nitriding and to a modified process known as carbonitriding characterised by a change of the gaseous atmosphere in which the process is conducted. The investigations included: metallographical examinations, determining the phase and chemical composition of the layers, their corrosion and frictional wear resistance and the scratch tests results.

The results obtained shows that the carbonitriding process of the Ti-6Al-3Mo-2Cr titanium alloy causes the increase of the microhardness and frictional wear resistance without any deteriorating the corrosion resistance in comparison with the nitriding process under glow discharge conditions of that alloy. These techniques permit controlling the chemical composition and microstructure of the surface layers - parameters that essentially affect their performance properties. It should also be noted that the glow discharge activates considerably the process of the layer formation and reduces the treatment time. These processes also permit to treat parts from Ti-6Al-3Mo-2Cr titanium alloy of sophisticated shapes.

E-mail: aflesz@inmat.pw.edu.pl

2. CORROSION PROTECTION OF TITANIUM BY DEPOSITION OF NIOBIUM THIN FILMS

R. Günzel, S. Mändl*, E. Richter, M. Soltany
Forschungszentrum Rossendorf, Institute of Ion Beam Physics and Materials Research, P.O. Box 51 01 19, 01314 Dresden, Germany
X. B. Tian, Z. M. Zeng, B. Y. Tang, P. K. Chu
Dept. of Physics & Materials Science, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon, Hong Kong
* Present address: Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany

Titanium and titanium alloys (e.g. Ti-6Al-4V) are widely used for aerospace or biomedical applications, as they exhibit a favourable combination of mechanical and chemical properties. Some of these characteristics are a high strength to weight ratio, bioinertness and corrosion resistance. While Ti-6Al-4V is highly corrosion resistant in the human body, corrosion can occur under special circumstances like the very acidic environment for tooth implants. One possibility to alleviate this problem is the surface modification of the titanium alloy by niobium deposition or implantation. Ion implantation of Nb results in an increased corrosion resistance and a stabilisation of the Ti-phase.

In this report, we present first experiments for depositing niobium thin films on titanium and titanium alloy (Ti-6Al-4V). The layers were produced using both a dc-sputter source with niobium target and argon plasma at a pressure of 10 Pa and a voltage of 1 kV and a MEVVA source in a custom designed plasma treatment system at the City University of Hong Kong. As poor adhesion of deposited layers is often observed, the possibility of using energetic ions during the initial phase for interface mixing and increased adhesion was investigated. Hereto the plasma immersion mode of the chamber was used. High voltage pulses with a height of – 25 kV, a length of 50 μs and a repetition rate of 100 Hz were applied to the samples, accelerating argon ions to the surface.

Potentiodynamic polarization measurements for the corrosion tests were performed in 5N HCl. An increased corrosion resistance with a corrosion current decreasing by 1.5 orders of magnitude was found for some films, depending on the process parameters. Elemental depth profiles and determination of the layer thickness were performed using Auger electron spectroscopy sputter depth profiling. Additionally contamination of the films with oxygen, carbon, and nitrogen was investigated with this method. Rutherford backscattering experiments were used for determining the absolute niobium area density. Furthermore the surface topology was investigated using an atomic force microscope to attempt a correlation of the corrosion data with the topology.

3. Preparation of diamond films on carbon steel substrates by ECC-EACVD

Xiaohui Wen, Mingcheng Gao, Rujuan Zhan, Haiyang Zhou, Xiaodong Zhu
Structure Research Laboratory, Chinese Academy of Science, Hefei, Anhui, 230026, P.R. China
Department of Modern Physics, University of Science and Technology of China,Hefei, Anhui, 230026, P.R. China

Diamond's high hardness, high thermal conductivity as well as its chemical inertness and wear resistance are of great interest for industrial application. Up to now, in the area of tool coating, the problem of how to apply diamond to WC-Co has been solved, but the challenge of coating ferrous surface -a huge commercial opportunity remains an issue[1].

Deposition of diamond on iron-based, stainless steel substrate is usually quite difficult:

1.It is extremely difficult to nucleate diamond particles on the materials like nickel, iron-based, etc, because of the catalytic effects of these elements on gas precursors such as methane to form soot. Moreover the rapid diffusion of carbon species into the iron-based metals, such as carbon steel and stainless steel, consumes a significant portion of carbon species on the substrate surface, which is necessary for diamond growth.

2.The coefficient of thermal expansion mismatch between the films and substrates (such as iron, steel, alumna, etc) will result in poor adhesion properties.

We use amorphous carbon buffer layer to synthesize successfully continuous diamond films on stainless steel substrates.[2] The amorphous carbon film formed on stainless steel is used as a diffusion barrier for carbon species, and this thin buffer layer inhibits surface catalytic effect, but the diamond films synthesized by this method is not good for adhesion on the substrates. Thus, for a large number of industrial applications, it is very necessary to find out a method which can synthesize diamond films with good adhesion on iron-based material.

In this paper, we present a new method for growing diamond films on carbon steel substrate using a combination method of electodeposited composite coating (ECC) and electron assisted chemical vapour deposition (EACVD). The Fe-In composite buffer layer inlaying diamond particles is formed on substrate by ECC, the diamond particles on surface of buffer layer grow up and join together to cover the substrate after EACVD. The adhesion between diamond film and substrate is very strong.

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Email: rjzhan@ustc.edu.cn

4. Investigation of the structure and properties of a-C: H with metal interlayers

M. Nöthe, F. Koch*, H.J. Penkalla, W.P. Rehbach**, H. Bolt*
Forschungszentrum Jülich, Institute for Materials and Processes in Energy Technology, D-52425 Jülich, Germany
*: Max-Planck-Institut für Plasmaphysik, D-85748 Garching
**: Aachen Technical University, Central Laboratory for Electron Microscopy, D-52074 Aachen

Wear resistant protective coatings like hard amorphous carbon (a-C: H) often suffer from poor adhesion. The application of interlayers with graded transition zone between the interlayer metal and the a-C: H film is used to improve the adhesion. The graded transition zone enlarges the interface between the carbon layer and the interlayer metal. Carbide forming metals (e.g. Al, Ti, Cr, W) can improve the chemical bonding compared with a substrate material, that can't form carbides extensively. The metal atoms were evaporated and ionized in