Poster

IMPROVEMENT OF SURFACE HARDNESS IN NITROGEN IMPLANTED V-5%Ti ALLOYS: INFLUENCE OF THE PREFERENTIAL SPUTTERING IN THE ELEMENTAL COMPOSITION DETERMINATION.

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Among the binary vanadium alloys, the V-5wt% Ti composition is interesting because of its low ductile-brittle transition temperature, very low void swelling and high creep resistance[1]. The origin of these useful properties is attributed to the microstructure of defects induced by the Ti atoms.

Ion implantation represents one surface treatment allowing the wear resistance of materials to be enhanced and their tribological properties to be improved. For metals, ion implantation is effective under high doses, exceeding 10^{16} cm^{-2} and ion energies exceeding 20 keV [2].

The main aim of this work has been to study the influence of the preferential sputtering in the elemental composition of nitrogen implanted V-5at%Ti at high energy and to characterize the improvements achieved in the tribological performance of this alloy.

Vanadium alloy ball shaped with a Ti concentration of 5 at% was produced from 99.9% V and 99.5% Ti by repeated arc melting in a high-purity He atmosphere and was annealed at 1573 K for 6 hours. Samples were prepared by cutting discs and the surfaces were polished with 1 μm diamond past. V-5%Ti sample was implanted with atomic N^+ ion at 100 KeV (5×10^{17} cm^{-2}), and with two successive molecular N_2^+ implantation at 100 KeV (9×10^{16} cm^{-2}) and at 50 KeV (4.4×10^{16} cm^{-2}). Using a simulation computer program flat profiles for the nitrogen concentration with values of 40% were obtained.

To obtain experimental depth profile for the relative concentration of elements on these vanadium alloys, surface were etching layer by layer with incident argon ions at 3 keV of energy and was studied by X-ray photoelectron Spectroscopy (XPS) and Auger electron Spectroscopy (AES) techniques. However, changes of surface-layer composition were obtained when surface was bombarded with 1.4 keV Ar^+ incident energy. The selective sputtering of carbon and oxygen atoms is energy depending and could change a factor of a 50%. However, the AES intensity corresponding to nitrogen, vanadium and titanium does not decrease in the same amount and preferential sputtering is not so evident at these two energies. By the contrary, Ar^+ ion sputtering at 6 keV previously reported [3] estimated a value of 1.4 of the nitrogen selective sputtering coefficient relative to titanium. Consequently different element concentration is obtained when studying samples at different Ar^+ ion sputtering energy. XPS spectra from the core electron level and valence bands are discussed.

In the present work, high energy nitrogen implantation (> 50 keV) samples [4] was studied (i) at maximum indentation loads of 2, 5, 25, 100 and 750 mN, (ii) the friction coefficient at contact pressure of 0.4. 0.5 0.6 and 0.65 GPa and (iii) the wear coefficient (m^2/N) at load of 0.25 ,0.5, 0.75 and 1N. Hardness increase is associated with the N implantation, suggesting nitride precipitation. XPS structure of the C_{1s} , N_{1s}, V_{2p} and Ti_{2p} obtained at different depths from the surface were deconvoluted using Gaussians after background subtraction. Nitride formation is studied and compared with previously reported values for V-N [5] and Ti-N [6].

The improvements achieved in the tribological performance of V-5 at%Ti alloy ion implanted with nitrogen at high energy are compared with those previously reported at low energy (1.2 keV) and at a temperature between 700-800 K [7],[8]. Hardness enhancement of these thermally activated nitrogen implanted alloys were due to the increasing of both, the thickness of the diffusion layer and the relative nitrogen content in the solid solution.

References:

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