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Structural Evolution of Electrodeposited Ni Coating on Ti-6Al-4V Alloy during Heat Treatment

Authors : M. Abdoos, A. Amadeh, M. Adabi

Abstract : In recent decades, the use of titanium and its alloys due to their high mechanical properties, light weight and their corrosion resistance has increased in military and industry applications. However, the poor surface properties can limit their widely usage. Many researches were carried out to improve their surface properties. The most effective technique is based on solid-state diffusion of elements that can form intermetallic compounds with the substrate. In the present work, inter-diffusion of nickel and titanium and formation of Ni-Ti intermetallic compounds in nickel-coated Ti-6Al-4V alloy have been studied. Initially, nickel was electrodeposited on the alloy using Watts bath at a current density of 20 mA/cm2 for 1 hour. The coated specimens were then heat treated in a tubular furnace under argon atmosphere at different temperatures near Ti β-transus to maximize the diffusion rate for various durations in order to improve the surface properties of the Ti-6Al-4V alloy. The effect of temperature and time on the thickness of diffusion layer and characteristics of intermetallic phases was studied by means of scanning electron microscope (SEM) equipped with energy dispersive X-ray spectrometer (EDS) and microhardness test. The results showed that a multilayer structure was formed after heat treatment: an outer layer of remaining nickel, an area of intermetallic layers with different compositions and solid solution of Ni-Ti. Three intermetallic layers was detected by EDS analysis, namely an outer layer with about 75 at.% Ni (Ni3Ti), an intermediate layer with 50 at.% Ni (NiTi) and finally an inner layer with 36 at.% Ni (NiTi2). It was also observed that the increase in time or temperature led to the formation of thicker intermetallic layers. Meanwhile, the microhardness of heat treated samples increased with formation of Ni-Ti intermetallics; however, its value depended on heat treatment parameters.

Keywords : heat treatment, microhardness, Ni coating, Ti-6Al-4V
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