Analysis of depth profile components at the Interface of Ti6242 Alloy and TiNi Coatings after High Temperature Oxidation in Air

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We have analyzed the interfacial elemental depth profile evolution after high temperature isothermal oxidation of NiTi coatings deposited by dynamic ion mixing on a Ti6242 alloy (Ti-6Al-2Sn-4Zr-2Mo). NiTi coatings (thickness 0,4μm) were deposited at room temperature (RT) by ion beam sputtering using a Kaufman type ion source of 7.5 cm diameter and the samples are mounted on a rotating substrate holder. A water cooled $Ti_{50}Ni_{50}$ target of 10 cm diameter was sputtered with 1.2 keV Ar^+ ions and ion beam mixing during the film deposition was performed with 120 keV Ar^+ ions. High temperature isothermal oxidation tests in 1 atm flowing synthetic air (80% N_2, 20% O_2) have been conducted at 500°C and 600°C during 100 hours.

We have observed a non-monotonous depth distribution of nickel in GDOES depth profiles after oxidation of TiNi/Ti6242: nickel segregates to the surface of TiNi coating an to the interface between TiNi coating and Ti6242 alloy. We propose a kinetic model based on rate equations for analyzing the depth profile. This model includes microprocesses taking place during oxidation in air such as: adsorption of nitrogen and oxygen, diffusion of components through the film and interface, formation of chemical compounds. The calculations are based on a monolayer approach where the equations are written for each component in each monolayer. It is shown by modeling that non-monotonous depth profile of nickel occurs because nickel from TiNi coating is forming a nickel oxide compound when oxygen atoms reach the film/alloy interface. As a result the atomic concentration of nickel decreases at the interface which induces a diffusion flux of atomic nickel from the bulk to the interface. This process leads to the increase of the total amount of nickel at the film interface and at the surface of coating and thus formation of non-monotonous depth profile. It is shown that the process of nickel oxide formation at the interface plays an important role and acts as a protective barrier for further penetration of oxygen atoms into the Ti6242 alloy. XRD analysis confirms the presence of nickel oxide in the TiNi/Ti6242 interface after oxidation at both temperatures 500°C and 600°C.