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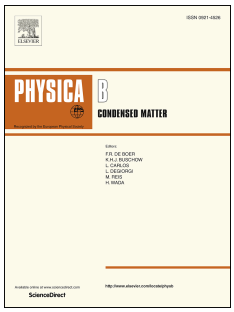

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Evaluation of Palladium Diffusion in Ti-Rich TiNi Alloys

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Abstract

In order to study the diffusion kinetics of Pd into Ti-rich TiNi alloys, diffusion annealing treatments of palladium-coated Ti53Ni47 and Ti50.2Ni49.8 alloys were carried out at temperatures ranging from 700 to 1000°C. Linear Arrhenius temperature dependencies with the pre-exponential factors of $2\pm1.1\times10^{-10}$ and $1.05\pm1.5 \times 10^{-8}$ m^2 s^{-1} and the activation energies of -128±4 and -153±10 kJ mol^{-1} were obtained for Pd diffusivity into Ti53Ni47 and Ti50.2Ni49.8 alloys, respectively. The suggested mechanism for Pd diffusion in Ti53Ni47 was anti-site bridge mechanism. While the rapid diffusion of Pd in Ti50.2Ni49.8 was attributed to the high volume fraction of vacancies in Ni sub-lattice of TiNi lattice and Next Nearest jumps of Pd atoms into abundant Ni vacancies. The lower diffusivity of Pd in Ti53Ni47 was related to the dominant diffusion mechanisms in two systems and low solubility of Pd in Ti_2Ni precipitates which located in grain boundaries, as well.

The other part of the study was denoted to inter-diffusion studies in Ti53Ni47/Pd and Ti50.2Ni49.8/Pd diffusion couples, which confirmed the higher diffusivity of Pd in Ti50.2Ni49.8.

Keywords: Diffusion coefficient, Palladium, TiNi, Inter-diffusion

1. Introduction

Shape memory alloys are a group of smart materials that can be used as thermal actuators because of their ability to produce mechanical work against a load.[1,2] NiTi actuators can supply large forces with small volumes and simple designs and operate with a simple mechanism -as well.[3,4] A reversible martensitic transformation between the high-temperature phase (austenite) and low-temperature phase (martensite) is responsible for the actuation process.[5] The temperature of the martensitic transformation, and therefore the temperature of the actuation process, is highly dependent on the chemical composition of the alloy.[6,7] It has been reported that the transformation temperatures of NiTi alloys can be increased up to 500°C by adding elements such as Au, Pt, Pd, Hf, and Zr.[8-10] Therefore, in addition to room-temperature applications, the utilization of the NiTi-based actuators in high-temperature environments such as oil, gas and aerospace industries is also possible.[11] However, in spite of the mentioned advantages, NiTi alloys show a steep transformation strain over a narrow temperature range which leads to a weak position controllability responding to temperature changes