Fabrication and Corrosion Resistance of the Ti-rich Alloyed Layer on the Surface of NiTi Alloys

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In this paper, the Ti-rich alloyed layer was prepared on the surface of NiTi alloys by the plasma surface alloying technique. The surface and cross-section morphology, elemental composition distribution and structural characteristics of the films were assessed by scanning electron microscope (SEM), glow discharge optical emission spectroscopy (GDOES) and X-ray diffraction (XRD) techniques, respectively. The thermodynamic and kinetic corrosion properties of the Ti-rich alloyed layer were investigated under simulated body fluid conditions by using open circuit potential and potentiodynamic polarization tests. Electrochemical impedance spectroscopy (EIS) combined with equivalent circuit modelling was implemented to analyze the frequency response. The results showed that the cross-section microstructure was composed of a 10µm thick loose outer deposition layer and an 8µm thick dense inner diffusion layer, including the phases of Ti₂Ni, TiNi and Ti. The passive current density for the Ti-rich alloyed layer was around $1.1 \times 10^{-9} \text{ A} \cdot \text{cm}^{-2}$ and 40 times lower than that of NiTi substrate. The polarization resistance evaluated from the EIS was found to be increased approximately 10 times from $6.133 \times 10^5 \Omega \cdot \text{cm}^2$ for the uncoated NiTi sample to $7.558 \times 10^6 \Omega \cdot \text{cm}^2$ for the alloyed sample. These evidences illustrate that the Ti-rich alloyed layer possess higher corrosion resistance in SBF solution compared to the NiTi substrate. The Mass Spectrometry test results evidenced that the Ti-rich alloyed layer can significant inhibited the release of Ni ion into the human body system.

Keywords: NiTi alloys; Plasma surface alloying; Ti-rich alloyed layer; corrosion resistance; Adhesion strength

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