IMPROVEMENT OF PITTING CORROSION OF Ti-PLASMA SPRAYED NiTi SHAPE MEMORY ALLOY BY SEALING TREATMENT

Masaru Okuyama, Seisho Take and Yasuhiko Itoi
Dept. Material Chemistry and Bioengineering,
Oyama National College of Technology
771, Nakaguki, Oyama, 323-0806, Japan

Application of Ni-Ti shape memory alloy to implant materials has been studied, but it has not yet been used in practice because of high possibility to suffer from pitting dissolution in the body liquid environment containing chloride ions. The authors tried to protect it by covering the surface with the titanium coating by means of plasma spray technique. The sprayed layers were so porous that dissolution was rather accelerated in spite of much advantage of biocompatibility. Therefore, sealing of the pores in the plasma-sprayed layers was required to prevent pitting dissolution. In order to keep mechanical flexibility, to avoid filling up the pores and to prove long life time in the human body, metal sealants were employed.. Two types of sealing techniques, a dry process and a wet process were performed. As a dray process, titanium vapor deposition was practiced and as a wet one, platinum plating technique was adopted. These processes were studied and the sealing effect on pitting prevention was investigated by electrochemical polarization measurement and SEM observation and EPMA analysis.

For sealing by the dry process, vacuum evaporation technique with titanium metal was employed. Two kinds of procedures were taken. The first one was that after a titanium thin films was deposited on the alloy substrate in a vacuum chamber, a porous titanium layer was sprayed on it. The second one was reverse. The first case could not get any good results because the deposit films had weak contact to the alloy substrate. The second case gave good sealing effect with optimum combination of plasma-sprayed layer and vacuum deposited film in thickness. For comparison of two processes, the polarization curves are given in Fig.1. The sample of the first case shows lower current and higher pitting potential.

For sealing by the wet process, several methods were attempted, but metal plating was possibly considered. However, titanium plating was currently impossible at low temperature range. In stead of titanium, platinum plating was employed as an immune material. The current pulse plating technique was employed because it had advantage to assist plating deep into small holes. Supersonic wave was applied during pulse plating. The parameters of the pulse plating was examined to obtain good sealing effect. It was found that the pulse width and the rest time had strong effect on sealing performance. Figure 2 shows the polarization curves of the sample sealed by with Pt-pulse plating under an optimum condition and Fig.3 shows the SEM image and Ti, Pt line profile of EPMA analysis of its cross section.

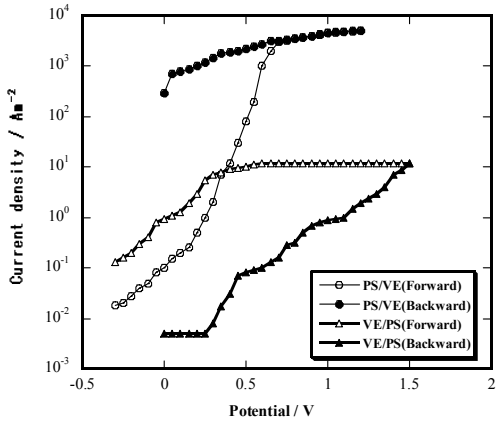

Fig.1 Polarization curves of Ti-sealed Ti-Plasma Sprayed Ni-Ti Alloy of Tow types in Physiological Solution at 40C

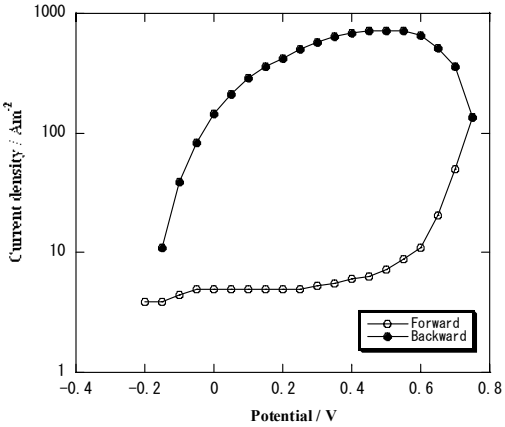

Fig.2 Polariation curves of Ti-sprayed Ni-Ti alloy sealed by Pt-pulse-plateding under an optimum condition physiological solution at 40C

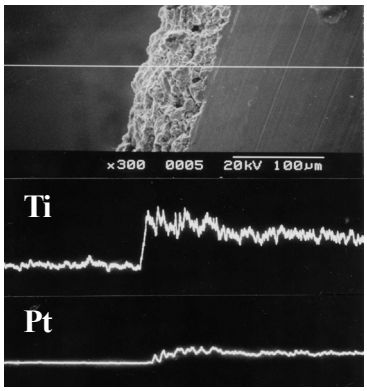

Fig.3 SEM image and Ti, Pt EPMA line analysis of cross section Ti-sprayed layer on Ni-Ti alloy sealed by Pt plating