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Nickel Suppression in Ni-Ti Alloys by Plasma Immersion Ion Implantation Surface Treatment: New Materials For Orthopaedic Implantation

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INTRODUCTION: Nickel-titanium shape memory alloys (NiTi) are promising materials in orthopedic applications due to their unique properties. However, for prolonged use in a human body, deterioration of the corrosion resistance of the materials becomes a critical issue due to the increasing possibility of deleterious ions released from the substrate to living tissues. We have investigated the use of nitrogen, acetylene, and oxygen plasma immersion ion implantation (PIII) to improve the corrosion resistance and mechanical properties of the materials.

METHODS: Circular NiTi discs with 50.8% Ni were implanted with nitrogen, oxygen and carbon using plasma immersion ion (PIII) implantation technique. The elemental depth profile and surface chemical composition of the PIII treated samples were determined by X-ray photoelectron spectroscopy. The surface hardness and corrosion resistance properties of all samples were measured. The solutions taken from each sample after the corrosion test were analyzed for Ni and Ti concentrations using inductively coupled plasma mass spectroscopy. To investigate the cyto-compatibility of the samples, mouse osteoblasts expressed an enhanced green fluorescent protein (EGFP) were used in cell culturing. Cell proliferation was examined after examined after 2, 4, 6 and 8 days of culture.

RESULTS: After PIII treatment TiN, TiO and TiC are formed on the surface layer of each specimen after treatment. When compared with untreated NiTi, the corrosion resistance was five-fold higher, and the surface hardness and elastic modulus were 2-fold higher (Table 1). The concentration of Ni in the simulated body fluid for the untreated sample was 30ppm compared to undetectable levels in the PIII treated sample. There was no difference in the ability of cells to grow on either surface (Figure 1).

Table 1. Young's modulus and hardness of control and the treated samples surfaces

Sample	NiTi	Nitrogen implanted	Carbon implanted	Oxygen implanted
Young's modulus (GPa)	57	150 – 65	110 – 70	150 – 55
Hardness (GPa)	4.5	11 – 5	9.5 – 4.5	9 – 3.5

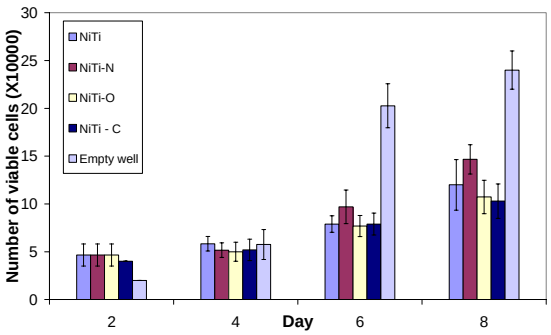

Figure 1. Cell proliferation versus number of days.

DISCUSSION & CONCLUSIONS: A number of surface modification schemes[1,2] have been studied to enhance the corrosion and wear resistance of NiTi alloys. However, PIII treatment is a method of nano-scale surface modification and not a coating, as such and unlike coatings, it does not de-laminate from the substrate. With enhanced corrosion and wear resistance, and negligible Ni release, PIII technology will allow NiTi alloys to be safely implanted in the human body. A new generation of "smart" orthopaedic implants will likely result.

REFERENCES: [1] Liu JX et al. (2003) *Thin Solid Films* **429**:225-230. [2] Villermaux F et al. (1997) *Applied Surface Science* **109-110**:62-66.

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