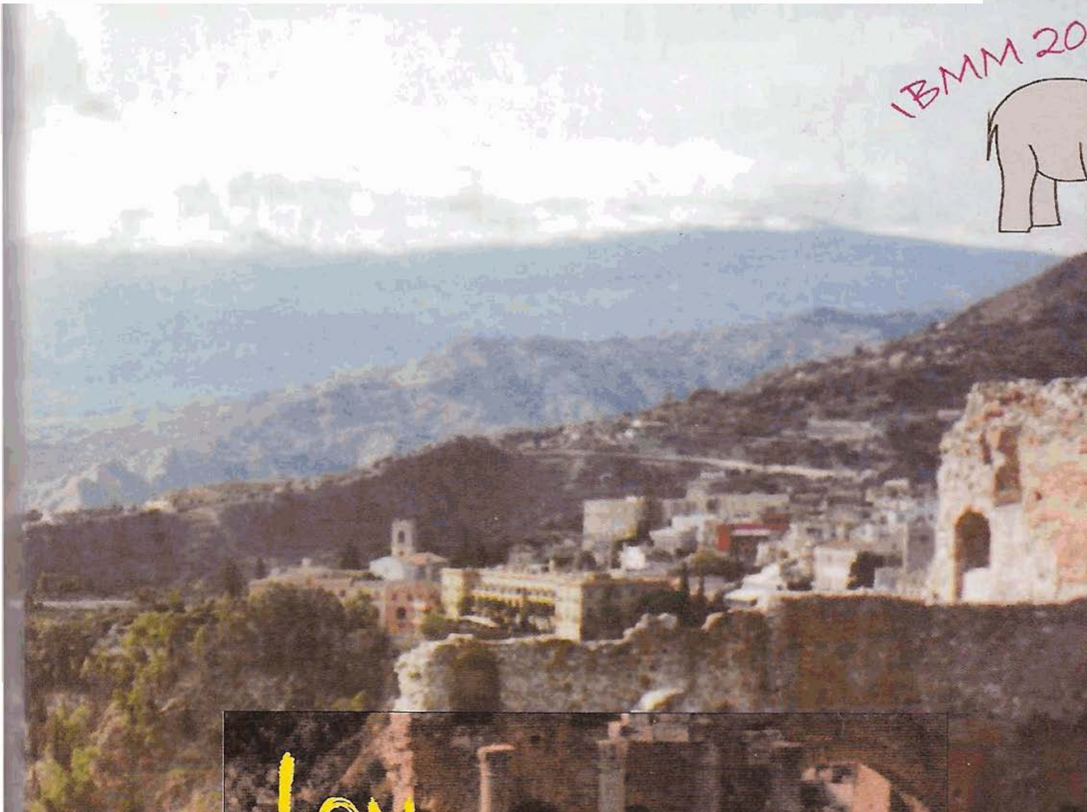
IBMM 2006

Program and Abstracts



Ion Beam Modification of Materials

15th International Conference

San Domenico Palace Hotel

Taormina - Italy

September 18-22, 2006

Session Chairs

Monday	I	J.W. Mayer
	II	S. Roorda
	III	N. Gerasimenko
	IV	M. Behar
Tuesday	V	H. Bernas
	VI	W. Moeller
	VII	C. Trautmann
Wednesday	VIII	P. Chu
	IX	C. Barbour
	X	E. Rimini
	XI	L. Rehn
Thursday	XII	S. Ashok
	XIII	Xi Wang
Friday	XIV	M. Nastasi
	XV	R. Elliman

Novel plasma-implanted shape memory alloys in orthopedics

K. Yeung[1], Y.L. Chan[1], K.O. Wong[1], X.Y. Liu[2], C.Y. Chung[2], P.K. Chu[2], W. Lu[1], K. Luk[1], D. Chan[3], K. Cheung[1]
[1]*Division of Spine Surgery, Department of Orthopaedics and Traumatology, Queen Mary Hospital, The University of Hong Kong, Pokfulam, Hong Kong*
[2] *Department of Physics and Materials Science, City University of Hong Kong, Kowloon, Hong Kong*
[3]*Department of Biochemistry, Faculty of Medicine, The University of Hong Kong, Pokfulam, Hong Kong*

Introduction: Nickel-titanium shape memory alloys (NiTi) have two distinctive properties, super-elasticity and shape memory, that most other current medical metallic materials do not possess. These 'smart' materials are potentially very useful in orthopedics and dental surgery. Release of toxic nickel particulate debris, however, remains a major concern in particular to spinal implant where fretting is always expeeted at the implant junction. We have therefore developed a plasma-based method to alter the surface chemistry of the materials in order to reduce nickel release. By using plasma immersion ion implantation (PIII), the surface properties of NiTi can be improved. This paper describes the corrosion resistance, surface mechanical properties, cytocompatibility, and *in-vivo* performance of PIII treated and untreated NiTi samples.
Methodology: NiTi discs containing 50.8% Ni were treated by nitrogen PIII at 40kV and 200Hz. The elemental depth profiles, surface chemistry, surface hardness and corrosion resistance were determined and compared to those of untreated NiTi. The amount of Ni released into simulated body fluids after the accelerated corrosion tests were determined by inductively coupled plasma mass spectrometry (ICPMS). The cytocompatibility was assessed by culturing mouse osteoblasts expressing an enhanced green fluorescent protein on the surface of these materials. In our animal tests, both the nitrogen plasma-treated and untreated NiTi samples were implanted into the rabbit femur and ilium for 2, 4 and 12 weeks.
Results: After PIII treatment, a layer of stable titanium nitride is formed on the NiTi surface. Compared to the untreated samples, the corrosion resistance of the nitrogen PIII sample is better by a factor of five and the surface hardness and elastic modulus are better by a factor of two. The concentration of Ni leached into the simulated body fluids from the untreated samples is 30ppm, whereas that from the nitrogen PIII that is undetectable. Although there is no significant difference in the ability of cells to grow on either surface, bone formation is found to be better on the nitrogen PIII sample surface at every time points.
Discussion and conclusion: The results acquired from the nitrogen PIII samples are more superior, for instance, enhanced corrosion and wear resistance as well as negligible Ni release. All these improvements can be attributed to the formation of titanium nitride on the surface. Furthermore, the plasma-treated NiTi also shows better bone growth in our animal study. There is evidence that the PIII modified NiTi alloy is suitable for orthopedic implants without inducing harmful effects.