Cell Adhesion Selectivity of Stent Material to improve Bio-functionality by Ion Beam Modification

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1. Introduction

Ion implantation method is world-widely used for high quality semiconductor production, and development for new materials to have special properties [1,2]. Ion implantation technology, which is one of ultramodern technologies, can be used in enhancing chemical and physical properties of materials, such as anti-corrosion, wear resistance and electrical conductivity.

In recent years, ion implantation has been applied to the surface modification of prosthesis to improve blood compatibility[3-5] and tissue compatibility[6] in field of biomedical application. As well known, bio compatibility was concerned with the cell adhesion selectivity for bio-functionality. The biomedical application of ion beam technology would be used more widely in the future such as catheter and artificial graft.

In this study, ion implantation into collagen coated Co-Cr alloy, which is a cheaper material of the artificial stent product (Fig. 1) comparing with Ti alloy, has been studied to develop small diameter artificial stent by the cell adhesion control. The size of stent was 1.6mm of the diameter and 18mm of the length. The life-time of artificial stent depends on adhesion property of endothelial-cells.

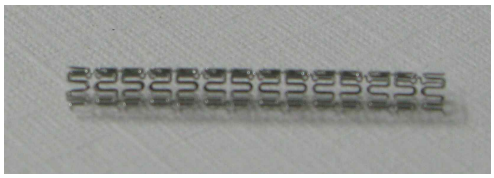


Fig. 1. The shape of artificial stent

2. Experimental

Co-Cr alloy metal discs (L-605 alloy, which is same material of stent product, 10mm of diameter×1mm of thickness) were used as a test material (base material). The chemical composition of the alloy metal is shown in Table 1. The base material was annealed at 1200°C for 5 min, followed by water quenching.

And then base specimen was coated by collagen (0.1 vol%) solution using the 24-h dip-coat method at 4°C. The discs were then dried at 4°C for 24 h. He^+ ion implantation was performed at 100keV, 1×10^{16}ions/㎠ with the surface of the dishes oriented vertically to the ion beam. The ion beam current density was 2.54 ㎂/㎠.

These ion-implanted collagen coated Co-Cr discs were compared with base material disc and non-ion implanted collagen-coated Co-Cr discs using endothelial cell(Human Umbilical Vein Endothelial Cell, Life Technologies(Gibco)) and muscle cell (Smooth muscle cell(A10, ATCC)) attachment test and a blood platelet adhesion to investigate the effect of collagen coating and He^+ ion beam irradiation.

Table 1. Chemical composition of materials used (wt.%)

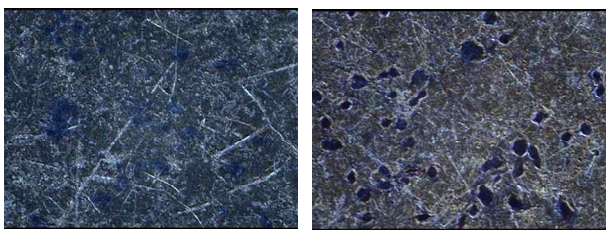
Alloy	Co	Cr	W	Ni	Fe	Mn
L-605 alloy	51.3	20.5	14.8	10.6	1.6	1.2

3. Results

In-vitro Endothelial Cell Attachment

We investigated endothelial cell attachment and cell viability with He^+ ion beam treatment on collagen coated Co-Cr alloy discs.

Fig 2 shows morphology of endothelial cell attachment on collagen coated and ion implanted specimens comparing with non-ion implanted specimen after incubation of 5 days by using digital microscopy. As shown in Fig. 2, the endothelial cell adhesion property was enhanced comparing with non-ion implanted specimen. Also, we measured the cell viability of ion implanted and non-ion implanted specimen by using MTT assay. (Fig. 3) As a result, the cell viability of ion implanted specimen was dramatically increased up to 160% comparing with control specimen (cell proliferation on Poly-L-lycine coated petri-dish).



(a) Co-Cr alloy (b) Collagen Coating & Ion Beam

Fig. 2. Endothelial cell adhesion test (Digital Microscope (×500))

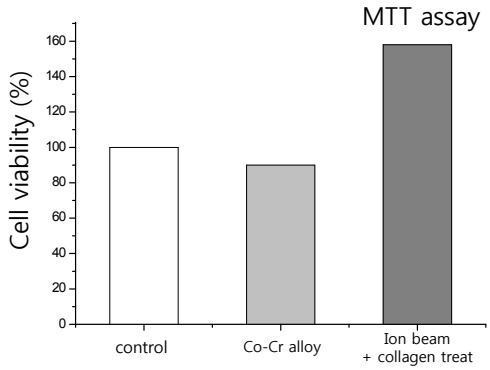


Fig. 3. The ratio of endothelial cell viability by using MTT assay.

In-vitro Muscle cell detachment

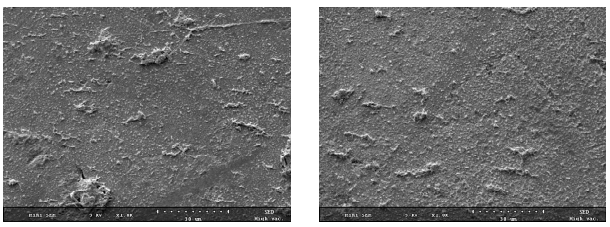
For application to artificial blood stent, muscle cell detachment on surface of artificial stent was also important. We investigated muscle cell viability with He^+ ion beam treatment on collagen coated Co-Cr alloy discs comparing with non-ion implanted specimen after incubation of 5 days. As a result, the cell viability of ion implanted specimen was dramatically decreased down to 32% comparing with control specimen (Table. 2).

Table 2. The ratio of muscle cell viability by using MTT assay.

Cell Viability (%)	Control	Co-Cr alloy	Ion Beam (1E16)
	100.0	43.2	32.2

In-vitro Blood platelets Attachment

Fig. 4 shows the in vitro blood platelet adhesion on the non-implanted Co-Cr and the He^+ ion implanted collagen-coated Co-Cr alloy using SEM. However, platelet activation and adhesion also occurred on the ion-implanted collagen surface comparing with non-ion implanted Co-Cr alloy. So, we need to find the optimum surface treatment condition for inhibition of platelet adhesion.



(a) Co-Cr alloy (b) Collagen Coating & Ion Beam

Fig. 4. Blood platelets attachment test

4. Conclusions

We successfully controlled cell adhesion selectivity between endothelial cell and muscle cell by using collagen coated and He^+ ion beam irradiated Co-Cr-alloy to apply to artificial stent. But, we did not achieve the inhibition of platelet adhesion, yet by using collagen coating and He^+ ion beam irradiation.

Based on this study, we have plan to research about separation between collagen coating effect and ion beam effect. Also, we will have more detail analysis of the mechanism of cell attachment.

ACKNOWLEDGMENTS

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