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Control of Human Osteoblast adhesion on polymers after ion beam irradiation

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INTRODUCTION: when a biomaterial is inserted in the body, the biological responses are associated with their surface properties. Surface treatments are developed to create some mimetic polymer or biomaterials with high performances, preserving the bulk properties and creating some specific interaction between the designed surfaces and the bio molecules or the cells. Some applications require the control of the cell behaviour: protein adsorption, cell proliferation, cell differentiation, cell mobility, spreading etc. The field of polymers application is vast and the surface treatment must be adapted: biosensors, tissue engineering, tissue regeneration, neural probes, drug delivery, bio-actuators etc.

METHODS: The surface treatment of organic materials by ion beam offers some advantages [1-3]: the depth of treatment is well controlled, the treatment could be local or total without mask (at the scale cell), surface modifications (scission, cross-linking, grafting, topography etc.) depend on the parameters of irradiation, and the treatment process is clean and realised in high vacuum. Polymers samples (PTFE, PMMA, PEEK, PET, HDPE, Parylene) are irradiated with a 900 keV Helium beam produced by a Van de Graaf Accelerator. The Polymers are cut out by a water jet at 13 mm diameter to be easily put in the cellular culture box. Three lines of irradiation are realized on each sample (line: 500 µm width, 6 mm length).

Cell cultures are done with an Osteoblast hFOB 1.19 lines from ATCC. After the treatment, samples are sterilized. Then they are immerged in a PBS medium culture heated at 37 °C. 10 000 Osteoblast cells are introduced with a pipetman and let incubated during 96 hours at 37° C with 5% of CO2. The cells are fixed with formol and after rinsing the cells are coloured with a blue Toluidine solution, then they are cleaned and let dried. Observations were performed with an Olympus® microscope.

RESULTS: No cell adhesion was observed on the PS, PTFE and PEEK material without any treatment. For the majority of the treated polymers, the cell adhesion depends on a threshold doses (number of atoms/cm^2): 5.10^{11} at/cm^2 for the PS and 5.10^{13} at/cm^2 for PTFE and PEEK. To induce some significant modifications which facilitate the cell adhesion on PEEK and PTFE polymers, it is necessary to multiply the dose by a factor 100 compared to the PS. In some particular case, a local treatment allows the cells to colonize the whole surface.

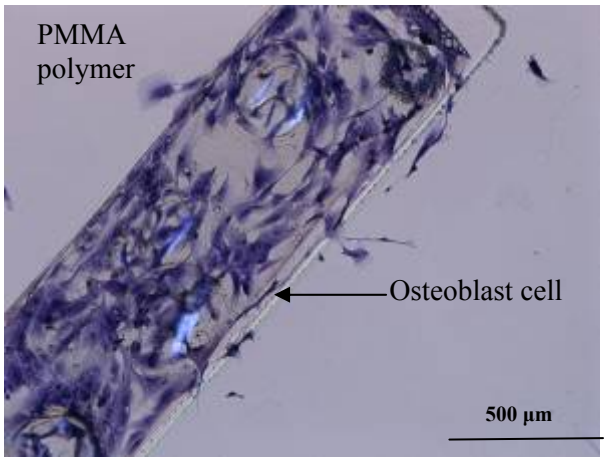

Fig. 1: Control of the adhesion of the Human Osteoblast cell on PMMA polymer. In this case cells adhere directly on the line of irradiation (900 keV He beam, .Dose 5.10^{14} at/cm^2).

DISCUSSION & CONCLUSIONS: This study shows that by selecting the appropriate parameters of irradiation, the control of the cell adhesion is possible. Theses parameters (dose, time of treatment) have to be adapted according the kind of polymer. Some chemical and topographical modifications are induced on the surface without affecting the bulk properties at the micrometer scale cell. Irradiation by He beam do not bring any pollution during the treatment nor toxicity.

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