Plasma polymer deposition on scaffolds of poly(D,L)lactic acid. Effect on the adhesion and the proliferation of fibroblasts, osteoblasts and keratinocytes

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Polylactic acid (PLA) is a biodegradable aliphatic polymer existing both as P(L)LA and P(D,L)LA. PLA undergoes scission in the body to lactic acid with L-lactic acid as a natural intermediate in carbohydrates metabolism[1]. Although PLA good biocompatibility, its surface presents low wettability and low surface energy that affect cell adhesion and proliferation[2]. In this paper an interesting atmospheric pressure plasma treatment is described to modify poly(D,L) lactic acid scaffolds surface properties, in order to enhance protein adsorption and consequently its ability to induce cell adhesion and proliferation[3]. The physico-chemical properties of the resulting surfaces are investigated by water contact angle (WCA), FTIR-ATR spectroscopy, X-Ray photoelectron spectroscopy (XPS) for C1s, O1s and N1s. The adsorption of proteins from bovine serum was then studied as a function of gas plasma treatment. Also cell adhesion and cell proliferation on plasma modified PLA sample were assessed. The first macroscopic effect observed after cold plasma treatments was a change in wettability of the PLA scaffolds. The FTIR-ATR analysis showed the presence of the ester groups such as OH and NH_2 functional groups. The XPS spectra confirmed on the one hand the incorporation of additional carbonyl, carboxyl or hydroxyl functional groups when acrylic acid was employed as precursor, on the other hand the incorporation of amino, amido and imino functional groups occurred when was employed 1,2-diaminopropane.
PLA-COOH was able to adsorb an higher protein concentration compared to normal PLA, while surprisingly also PLA-NH_2 increased the quantity of adsorbed protein. Murine fibroblasts (3T3), murine pre-osteoblasts (MC-3T3) and human keratinocyte (HaCaT) were able to adhere on PLA and plasma modified PLA, but MC-3T3 showed a higher affinity for PLA compared to the other cell types and this affinity was even higher onto PLA-COOH where pre-osteoblast spreaded, while this effect was less important onto PLA-NH_2. After 48 hours proliferation of adherent cells was assessed both observing cells stained with acridine orange and using the TOX-8 assay that scores cell number as a measure of mitochondrial activity: it was evident a good cell proliferation for both MC-3T3 and HaCaT cells. Moreover HaCaT cells formed an almost confluent cell layer onto PLA-COOH. As expected 3T3 fibroblast proliferated very slowly onto every surface.

References

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