Plasma processing of 3D scaffolds to address specific cell response suitable for long term implants and tissue engineering

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Tissue engineering emerged in the early 1990s to address limitations of organ transplantation and synthetic tissue replacements, focusing on coupling cells and a biocompatible matrix known as a scaffold [1]. Tissue engineering approaches are mainly based on the use of 3D biocompatible, bioerodable scaffolds, together with cells, to reconstitute a specific tissue *in vitro* that might be utilized for the replacement of diseased tissue *in vivo*. An ideal tissue-engineering scaffold should be porous and should possess an appropriate surface chemistry to induce desired cellular activities and to guide 3D tissue regeneration. Despite their adequate tailorable mechanical properties, synthetic polymers do not contain chemical features that are able to stimulate specific cell behavior, resulting in poor ingrowth of cells. This limitation could seriously compromise the future *in vivo* application of these scaffolds. For these reasons, plasma modification of 3D scaffolds could be an important approach to overcome these drawbacks. In order to overcome the problem of correct cell ingrowth, a plasma coating on the external surface of polycaprolactone (PCL) scaffolds (pore size ranging from 150μm to 300μm, [2]) was deposited. The chemical composition of the coating contains ether groups (e.g. Polyethylene oxide-like, PEO-like[3]) which are able to discourage cell adhesion. In this way cells are addressed to colonize the internal part of the scaffolds. FTIR and XPS analyses showed that the plasma deposited films, recognized by the presence of ether groups in the coatings, covered only the external surface of the materials. Cell viability tests showed that plasma processing was an effective approach to enhance cell adhesion. A combination of PEO-like coating deposition with an O_2 plasma treatment inside the scaffold core has also been used to improve the performances of 3D PCL scaffolds. In addition, in this work, an innovative strategy that combines cold plasma sputtering of hydroxyapatite and plasma treatments to produce calcium phosphate (CaPs) coatings on polymeric scaffolds useful for long term implants and tissue engineering [4] was experienced. Oxygen plasma treatments were used also in this approach, in combination with plasma sputtering, to produce an inner surface suitable to stimulate cell-adhesion. Biological tests show that cell clustering, spreadness and actin stress fibers were more evident on scaffolds treated with oxygen and oxygen plus CaPs with respect to the control (untreated PCL) and PCL coated with CaPs alone.

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