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Surface functionalisation, nanoroughness and drug delivery by atmospheric plasma jet on scaffolds

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Advances in tissue engineering have highlighted how roughness and surface chemistry in the scaffolds can affect cells growth and differentiation. Moreover the new generation of scaffolds focuses also on smart functions such as the delivery of growth factors or anti-inflammatory drugs and on the possibility to make gradients of the different properties or functions within the same scaffolds.
Here we present an innovative way to control nanoroughness, chemistry and drug delivery just by depositing them locally by spraying smart or inert nanoparticles and fixing them mechanically on the surfaces by an atmospheric plasma coating encapsulation. The size and quantity of the nanoparticles deposited allows a control of the roughness. The biodegradable nanoparticles allows the introduction of the smart functions or drugs and the plasma coating assures the desired surface chemistry. Since the whole process is in open-air, fast and localized, it is compatible with 3D-printing and allows gradients designs.
The new process has been evaluated on titanium alloys for dental implants for osteoblasts growth and on polycaprolactone (PCL) for fibroblasts growth. Silica and fluorescent PLA nanoparticles of 200nm in diameter have been used to induce the roughness. The fixing and the carboxylic and ammine groups surface functionalities have been obtained by atmospheric plasma coating around 150nm thick. The surfaces have been characterized by AFM, SEM and FT-IR, while cells growth have been evaluated by viability assay, protein absorption, proliferation and focal adhesion. All the parameters have been improved, cells adhesion has been increased of 20% relative to commercial large grits and acid etched (SLA) titanium alloys and of a factor 10 compared to smooth PCL. The possible drug release has been simulated quantifying the fluorophore coming from the PLA nanoparticles in the cells growing media.

Keywords
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