Vertically-Aligned MWCNT onto Electrospun PLA Fibers: A Straightforward Route to Create Bioactive and Electrically Conductive Nanoarchitectured 3D-Scaffolds

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Nanoarchitectonics have its premises based on the design of materials into functional 3D nano-scaled objects, through the synergism of multi-combinations, field-controlled organization and self-organization [1]. In this framework, we proposed a methodology for the production of scaffolds based on electrospun polyesters/vertically-aligned multi-walled carbon nanotubes (VAMWCNT). Herein, a novel nanoarchitectured material was designed in an inedited route based on the hot-press transfer of VAWMCNT onto the surface of electrospun poly (lactic acid) (PLA) fibers. As result of the synergism between both components, we have created a unique material that combined bioactive properties and electric conductivity, therefore expressing the bio-potential of PLA and the physical-chemical properties of VAMWNCT. Oxygen-plasma was used to functionalize the as-prepared PLA/VAMWCNT, which promoted the exfoliation of the VAMWCNT's tips (exposing graphene oxide sheets, GO) and attached oxygen-containing groups to the scaffolds' surfaces. X-ray photoelectron spectroscopy (XPS) results revealed a successful functionalization (18.9% of oxygen content), which was responsible to change the wettability from superhydrophobic (PLA/VAMWCNT) to superhydrophilic (PLA/VAMWCNT-GO). Electrochemical assays showed a notable increase in the electroactive area (1.5 fold) for PLA/VAMWCNT-GO. The value of k^o was 6.87 x 10^{-3} cm s^{-1}, pointing out the scaffold's applicability as 3D-electrode. Bringing attention to the potential of this novel material for bone tissue engineering, nanohydroxyapatite (nHAp) electrodeposition was carried out onto the scaffold's surface, aiming at improving the biomimetic properties. This process was only possible due to the conductive nature provided by VAMWCNT, since PLA itself presents insulating properties. Biological assays showed the viability of primary human osteoblast cells cultivated onto the final material (PLA/VAMWCNT-GO-nHAp). These results have demonstrated a practicable approach to produce bioactive and electrically conductive 3D-scaffolds from the transfer of VAMWNCT onto electrospun polyester matrices, which in turn may present a great potential towards tissue engineering.

[1] M. Aono, K. Ariga, Adv Mater. **28**, (2016), 989.