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Abstract

Advanced Electromechanical Devices for Use in Bone Tissue Engineering †

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With the increase in the prevalence of bone diseases and lesions, there is a need for advanced bone implants utilizing biocompatible materials that improve the healing process [1]. Current metallic implants have good mechanical properties but lack biocompatibility. This can be overcome by modifying the surface of the metallic implant materials, for example, by coating with polymers, such as Poly (L-lactic acid)(PLLA) [2]. PLLA has been used as a material for bone implants due to its biocompatibility, biodegradability, and piezoelectric properties, which have been shown to improve bone regeneration [3]. The piezoelectric properties originate from the crystalline zones of PLLA. This causes a significant impact on the degree of crystallinity, crystallite orientation, and crystal morphology on the piezoelectric properties [3]. By analyzing the effects of variables, such as the treatment of the stainless-steel surface, the temperature, the concentration of the PLLA solution, and the cooling and heating rates used during the crystallization, it is possible to better understand and adapt the crystallization behavior of PLLA coating. This knowledge could then be used to tune the properties of the implant devices for bone tissue engineering.

In this work, the stainless steel was submitted to either thermal treatment or UV irradiation followed by the silanization process to improve the adhesion between the PLLA and stainless steel. A thin film of PLLA was deposited on top of the stainless-steel substrate via spin coating with PLLA solution concentrations of 2.5 wt% or 5.0 wt%. The effect of the different pre-treatments on the efficiency of the adhesion is discussed, along with the impact on the morphology of crystalline PLLA. After deposition, the film was crystallized using different temperatures and cooling and heating rates. XRD, FTIR, Raman, AFM, and PFM results showed that the morphology of the crystalline PLLA films, as well as the crystallinity degree, were highly affected by the different variables used. Samples with a higher degree of crystallinity were obtained on UV-treated stainless-steel with lower cooling rates and with a higher PLLA solution concentration. However, the latter seemed to considerably decrease the adhesion between the PLLA film and the stainless-steel substrate.

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