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Investigation of Biomimetic Coatings on Glassy Carbon and Ti-6Al-4V Substrates: Impact of Varying Surface Preparation Methods

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Biomimetic coatings, an innovative advancement in biomedical engineering, replicate the complex mechanisms and properties observed in biological systems to enhance the performance, durability, reliability, and biocompatibility of biomedical implants [1-2]. These coatings aim to improve implant integration with the human body, addressing the challenges of traditional coatings like thermally sprayed hydroxyapatite (HAp), which can suffer from inherent residual stress, undesirable thermal products, poor biocompatibility, infection risk, and inadequate tissue integration [2]. By imitating natural biochemical processes, biomimetic coatings with better cellular adhesion, proliferation, and differentiation [3] can be produced. This study explores biomimetic deposition on Ti-6Al-4V (Ti64) and glassy carbon (GC) substrates, pretreated with sandblasting, plasma etching, and polishing, and then immersed in simulated bodily fluid (SBF) for 56 days. The resulting coatings were analysed using scanning electron microscopy (SEM) for surface morphology, energy-dispersive X-ray spectroscopy (EDS) for elemental analysis, atomic force microscopy (AFM), and X-ray diffraction (XRD) to evaluate their structural and compositional properties.
EDS analysis revealed higher Ca and P on coatings deposited on plasma-etched and polished GC substrates, while sandblasted Ti64 substrates showed higher O, Ca, and P. Plasma-etched GC and sandblasted Ti64 apatite coatings resembled thermally sprayed HAp layers on Ti64, indicating similar elemental compositions. Ti64 substrates subjected to polishing and plasma etching had lower element percentages due to pre-treatment. SEM images showed distinct surface morphologies: GC substrates had tightly packed spherical particles creating a rough texture, while sandblasted Ti64 substrates exhibited densely packed spherical clusters and plasma-etched Ti64 samples had small, uneven clusters forming a porous texture. XRD confirmed coatings on polished and plasma-etched GC and the sandblasted and plasma-etched Ti64 as hydroxyapatite with fine grain size. XRD analysis confirmed all patterns to display distinct peaks corresponding to apatite, confirming successful biomimetic apatite coating formation. The AFM measured the Young's modulus of the coatings and observed values within the range comparable to that of human cortical bone (17–25 GPa) [4]. These findings suggest that biomimetic coatings can successfully produce apatite coatings suitable for biomaterial implants, potentially improving implant integration.

Key words: Hydroxyapatite, Biomimetic mineralization, simulated body fluid (SBF), biocompatibility

[1] Smith, A. M., & Callow, J. A. (2016). Biomimetic Coatings for Biomedical Applications: Advances in Synthesis and Applications. Journal of Biomedical Materials Research Part A, 104(6), 1457-1472. doi:10.1002/jbm.a.35781.
[2] Zhao, L., Wang, H., Huo, K., Cui, L., Zhang, W., Ni, H., … & Chu, P. K. (2011). Antibacterial nano-structured titanium for biomedical applications. Nanomedicine: Nanotechnology, Biology and Medicine, 7(2), 177-185. doi:10.1016/j.nano.2010.10.004.
[3] Wang, X., Li, Y., Wei, J., & de Groot, K. (2002). Development of biomimetic nano-hydroxyapatite/poly(hexamethylene adipamide) composites. Biomaterials, 23(24), 4787-4791. doi:10.1016/S0142-9612(02)00207-0.
[4] D. T. Reilly and A. H. Burstein, "The elastic and ultimate properties of compact bone tissue," Journal of Biomechanics, vol. 8, no. 6, pp. 393-405, 1975.

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