Electrical and Biological Response of Biomaterials Based on Bioactive Glass Modified by Niobium Insertion for Implants Coatings

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Abstract

The demand for implantable medical devices has surged in recent decades. However, bacterial infections following implant placement are a frequent occurrence, resulting in the deterioration of the surrounding bone and eventual implant failure. Several studies have demonstrated the efficacy of bioglass in enhancing the success rate of dental implants through its promotion of tissue integration [1-3]. Notably, the release of sodium and calcium ions by bioglass has been found to disrupt the cell membrane, effectively restricting the growth of microbiological bacteria [4-5]. The objective of this study is to develop an antibacterial biomaterial for implant coatings in order to address the issue of implant infections. In this work, the melt-quenching technique was employed to produce a series of 45S5 bioglasses, incorporating niobium oxide (Nb_2O_5) at concentrations ranging from 0 to 8 mol%. The inclusion of Nb_2O_5 did not impact the structural properties of the glasses, as determined through XRD and FTIR. However, the structural characterization using Raman spectroscopy, reveals an alteration in glass structure with the insertion of niobium. To assess the biocompatibility of the bioactive glasses, human osteosarcoma SAOS-2 cells were utilized. The results demonstrated the viability and potential applicability of the prepared bioactive glasses in biomedical applications. It is widely known that the electrical properties of biomaterials influence their ability to integrate with the body tissue through osseointegration. Given the known electrical and dielectric characteristics of Nb_2O_5, we conducted an initial investigation into the electrical properties of these bioglasses. Thus, the effects of Nb_2O_5 on charge transfer mobility were examined using impedance spectroscopy across a frequency range of 10^2 to 10^6 Hz and over temperatures ranging from 200 to 400 K.

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