Examination of the surface layer of bioactive glass before and after immersion in SBF (Simulated Body Fluid) – Raman analysis.

P. Kapuśniak[1], P. Brągiel[1], M. Piasecki[1]
[1] Science and Technology Department, Jan Dlugosz University, Czestochowa, Poland
e-mail: Paulina.kapusniak@doktorant.ujd.edu.pl

Introduction: Bioglass has been extensively studied and hold great potential for various applications in modern medical practice, thanks to their customizable design and unique properties, such as chemical, antibacterial and bioactive characteristics. Researchers continue to explore new materials to enhance their effectiveness and gain a deeper understanding of the processes occurring at the interface between bioactive glass and physiological fluids. Once implanted in the human body, bioactive glass triggers the formation of a biologically active hydroxyapatite (HA) layer on the surface, resembling the mineral composition of bones and teeth. Additionally, the degradation of bioactive glass in natural body fluids, particularly, when exposed to Simulated Body Fluid (SBF), is another important property of interest. The bioactivity of the glass is significantly influenced by it's composition and dispersion. Magnetic bioactive glasses, in particular, hold promise healthcare applications such as cell separation and serve as contrast agents in magnetic resonance imaging [1-2].

Experimental: A series of Bioglass® samples doped with varying amounts of Fe_2O_3 were synthesized using a modified sol-gel method, following the procedure outlined by Fure and others [3]. The samples underwent characterization through several techniques including X-ray diffraction, Differential Scanning Calorimetry, Infrared Spectroscopy, Raman Spectroscopy, Scanning Electron Microscopy, Energy Dispersive Spectroscopy, and ICP-MS Analysis. To evaluate the bioactivity of the samples, in vitro immersion tests were conducted using an SBF, prepared according to the method proposed by Kokubo [4]. The samples and the SBF solution were examined after 6 hours, 24 hours, 1 week, and 2 weeks of immersion. Remarkably, all samples exhibited bioactivity regardless of the concentration of iron ions present.

Results and discussion: The SEM analysis revealed that as the Fe content in the glass increased, the samples exhibited higher porosity. The degradation of the samples in SBF occurred relatively quickly, with approximately 35-47% of the glass being degraded within a two-week period. Raman spectra and FT-IR spectra confirmed the formation of HA/HAC, and Raman spectroscopy imaging was employed to examine the distribution of HA/HAC on the surface of the samples and assess its penetration below the surface. It was discovered that the depth distribution profile of HA/HAC strongly correlated with the amount of the dopant present in the glass.

Conclusion: All of the obtained glasses exhibited bioactivity as evidenced by formation of HA on their surfaces upon immersion in SBF. Raman spectroscopy proved to be a reliable tool for confirming the presence of HA on the surface and examining it's distribution within the tested material.

References

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