DEGRADATION MECHANISM ON THE SURFACE OF SiO$_2$-P$_2$O$_5$-CaO HYBRID MATERIALS WITH POTENTIAL APPLICATION FOR BONE REGENERATION

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Healing low-quality bone fractures in osteoporotic bones or with critical size defects may suffer of several clinical complications since repairing the damage can take longer than desired. To prevent unforeseen difficulties, promising approaches are focused on the developing of fixation devices that induce a simultaneous quick bone regeneration and device degradation while assuring strength enough to sustain the formation of the new functional tissue. When soaking the CaO and P$_2$O$_5$ hybrid materials into Simulated Body Fluid, degradation of the silica-based matrix occurs together with the growth of an apatite layer on their surfaces. The dissolution kinetics of the materials depends on their composition, changing from a surface-driven mechanism for low-P$_2$O$_5$ content samples to a degradation path which can be fitted into a Weibull type kinetic model, typical of a matrix dissolution process in high-P$_2$O$_5$ content samples. A first burst at 72 h after immersion happens; afterwards, the concentration of ions in the solution becomes stable. The surface parameters were determined in terms of fractal constant and pores anisotropy. In low-containing P$_2$O$_5$ materials, the fractal constant shows a slight increase after a few hours of immersion, suggesting the formation of a homogeneous amorphous silica-like layer in the first stages of degradation, which also functions as a nucleus for the subsequent apatite formation. Pore anisotropy determination revealed that degradation leads to ink-bottle shaped pores, whose volume increases as the soaking time does, but the neck of the pore remains constant in shape.

Keywords: Degradation Kinetics, Hybrid Materials, Texture

References:


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