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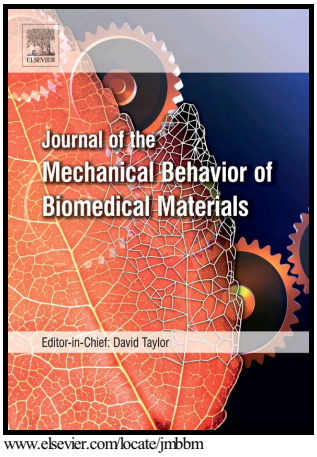
M. Bashir, S. Riaz, Z.N. Kayani, S. Naseem



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Synthesis of Bone Implant Substitutes using Organic Additive Based Zirconia Nanoparticles and their Biodegradation Study

M. Bashir[1], S. Riaz[1], Z.N. Kayani[2] and S. Naseem[1*]

[1]Centre of Excellence in Solid State Physics, University of the Punjab, Lahore Pakistan

[2]Lahore College for Women University, Lahore, Pakistan

[*]shahzad.cssp@pu.edu.pk

Abstract

Zirconia, a hard-ceramic, is potential material for bone and dental implants. However, the problem limiting its application is inertness. This problem can be minimized using body compatible and non-toxic organic additives. Organic additives-based zirconia (OZ) nanoparticles are synthesized using sol–gel method. Zirconium oxychloride is used as precursor and water as solvent. OZ nanoparticles are calcined in temperature range of 100-1000ºC. Transition from mixed zirconia phases to amorphous behavior is observed at 300ºC. Phase-pure tetragonal ZrO_2 (t-ZrO_2) along with reduced crystallite size ~12.7nm is observed at 500ºC. Mixed phases, started to appear at 800ºC, exhibit increased monoclinic to tetragonal ratio at 900-1000ºC. SEM images show OZ nanoparticles with ~50nm diameter at 500ºC. Nanoparticles with ~50nm and ~70-75nm diameter along with nanowires (~8nm) are observed at 600-700ºC. FTIR band at 500cm^{-1} along with shoulder at 580cm^{-1} and Raman band at 148 cm^{-1} confirm the presence of t-ZrO_2 at 500-600ºC. High value of hardness, ~15GPa, and dielectric constant (~55-68) suitable for bio-application, is observed for OZ nanoparticles calcined at 500ºC. Optimized t-ZrO_2 is immersed in stimulated body fluid for 1, 2, 4, 8, 13, 20 and 26 weeks. Small degradation in weight and hardness is observed even after 26 weeks of immersion.

Graphical Abstract