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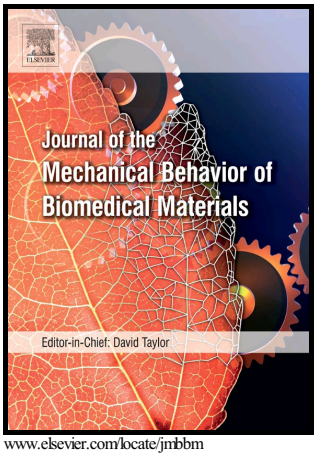

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Mechanical, Degradation and Drug-Release Behavior of Nano-Grained Fe-Ag Composites for Biomedical Applications

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Abstract

An original fabrication route of high-strength bulk Fe-5Ag and Fe-10Ag nanocomposites with enhanced degradation rate is reported. Near fully dense materials with fine nanostructures and uniform distribution of Ag nanoparticles were obtained employing high energy attrition milling of Fe-Ag_2O powder blends followed by cold sintering - high pressure consolidation at ambient temperature that allowed the retention of the nanoscale structure. Annealing in hydrogen flow at 550°C resulted in enhanced ductility without coarsening the nanostructure. The strength in compression of Fe5Ag and Fe10Ag nanocomposites was several-fold higher than the values reported for similar composites with micrometer grain size. The galvanic action of finely dispersed Ag nanoparticles greatly increased the corrosion rate and degradation kinetics of iron. Following four weeks immersion of Fe-Ag nanocomposites in saline solution, a more than 10% weight loss accompanied by less than 25% decrease in bending strength were measured. The interconnected nanoporosity of cold sintered Fe-Ag nanocomposites was utilized for incorporation of vancomycin that was gradually released upon immersion. In cell culture experiments, the Fe-Ag nanocomposites supported the attachment of osteoblast cells and exhibited no signs of cytotoxicity. The results suggest that the proposed Fe-Ag nanocomposites could be developed into attractive biodegradable load-bearing implant materials with drug delivery capability.