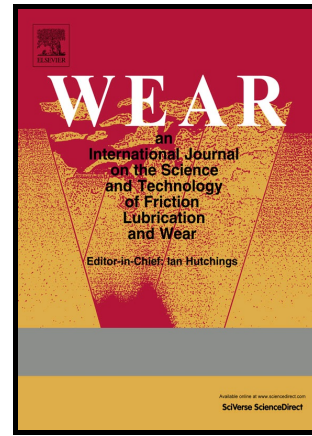


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Multi-length Scale Tribology of Hydroxyapatite Reinforced with Ceria and Silver

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Abstract

In order to control the inflammatory reaction and bone resorption due to wear debris and obtain a multi-functional composite with superior mechanical and tribological properties, antioxidant ceria (CeO₂) and antibacterial silver (Ag) nanoparticles are synergistically reinforced in hydroxyapatite (HA) matrix. Enhanced hardness (5.3 to 8.6 GPa), elastic modulus (120.8 to 167.9 GPa) and fracture toughness (0.21 to 0.90 MPa.m^{1/2}) and reduced brittleness index (24.8 to 9.6 μm^{-1/2}) of HA-CeO₂-Ag composite were achieved, when compared to that of HA. A multi-length scale tribological study (by dissimilar damage mechanisms in fretting and scratch) is presented. Observed herein, that enhanced mechanical properties elicited a wear resistance of 89% (by fretting) and 13% (by scratch), with synergistic CeO₂ and Ag reinforcement. Compression during fretting over a localized length (100 μm) resulted in the closure of pores, whereas micro-scratching exposed a higher number of interfaces (by an order of magnitude), reducing wear resistance at higher length scales. In summary, HA-CeO₂-Ag composite restricts tribological damage effectively over multi-length scales, thereby serving as an optimal substrate with efficient load-bearing capacity for orthopedic applications.

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