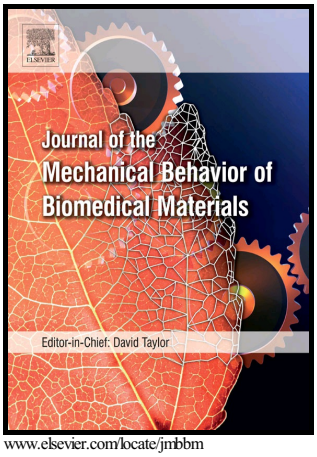

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Phase Pure, High Hardness, Biocompatible Calcium Silicates with Excellent Anti-bacterial and Biofilm Inhibition Efficacies for Endodontic and Orthopaedic Applications

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Abstract

Here we report for the very first time the synthesis of 100% phase pure calcium silicate nanoparticles (CSNPs) of the α-wollastonite phase without using any surfactant or peptizer at the lowest ever reported calcination temperature of 850°C. Further, the phase purity is confirmed by quantitative phase analysis. The nano-network like microstructure of the CSNPs is characterized by FTIR, Raman, XRD, FESEM, TEM, TGA, DSC etc. techniques to derive the structure property correlations. The performance efficacies of the CSNPs against gram-positive e.g., S. pyrogenes and S. aureus (NCIM2127) and gram-negative e.g., E. coli (NCIM2065) bacterial strains are studied. The biocompatibility of the CSNPs is established by using the conventional mouse embryonic osteoblast cell line (MC3T3). In addition, the biofilm inhibition efficacies of two varieties of CSNPs e.g., CSNPs(W) and CSNPs(WC) are investigated. Further, the interconnection between ROS e.g., superoxide (O_2^-) and hydroxyl radical (·OH) generation capabilities of CSNPs and their biofilm inhibition efficacies is clearly established for the very first time. Finally, the mechanical responses of the CSNPs at the microstructural length scale are investigated by nanoindentation. The results confirm that the α-wollastonite phases present in CSNPs(W) and CSNPs(WC) possess extraordinarily high nanohardness and Young's moduli values. Therefore, these materials are well suited for orthopaedic and endodontic applications.

Keywords: Phase-purity, wollastonite, antibacterial, cytotoxicity

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