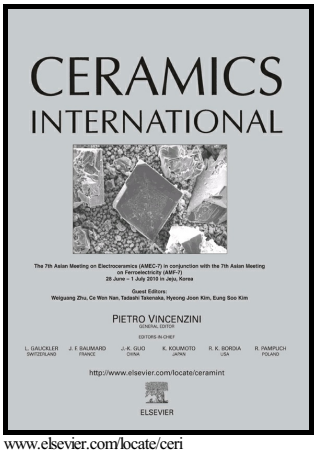

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Vibrations of beam-type implants made of 3D printed bredigite-magnetite bio-nanocomposite scaffolds under axial compression: Application, communication and simulation

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Abstract

Due to the Si-O-Si bonding, silicate bioceramics have enhanced mechanical characteristics than their calcium phosphate (CaP) counterparts. Bredigite with orthorhombic crystal system is one of the most efficient bioceramics in osteoblast and bone growth. On the other hand, biosilicate-magnetite composites (e.g. bredigite-magnetite and hardystonite-magnetite) are excellent candidates for hyperthermia applications. In the current study, the vibrational response of a beam-type bone implant subjected to axial compression is investigated. The implant is made of bredigite-magnetite bio-nanocomposite scaffold fabricated by 3D printing machine including 0.8 mm pore size. The Young's modulus of the scaffold is extracted experimentally corresponding to different magnetite nanoparticle (MNP) weight fractions, crystalline nanocomposite particle size, and various shapes of morphology. The morphology shape is determined corresponding to different MNP weight fractions and temperatures using scanning electron microscopy (SEM). Thereafter, an analytical solution is presented to express explicitly the load-frequency and frequency-deflection responses of the axially loaded beam-type bone implant. It is observed that in the prebuckling domain, by increasing the axial compressive load, the influence of the MNP weight fraction on the natural frequency of the bio-nanocomposite implant increases while in the postbuckling regime, increment in the axial compression has no effect on the significance of the MNP weight fraction effect.

Keywords: Nanotechnology; Bio-nanocomposites; Nonlinear vibration; 3D printer design; Biomedical scaffold.

1. Introduction

Osteoporosis is a common disease in old people and its treatment is costly that imposes a significant burden due to disability and impaired quality of life. It has been almost estimated that over 10 million persons over 50 years old in USA have osteoporosis by 2010 [1]. Osteoporosis causes to loss the inner lining of bone and leads to multiple fractures. Classification of composite is based on the matrix phase, such as: ceramic matrix composites (CMCs), polymer matrix composites (PMCs), and metal