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Research paper

Boron nitride nanotube reinforced hydroxyapatite composite: Mechanical and tribological performance and *in-vitro* biocompatibility to osteoblasts

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ABSTRACT

This study proposes boron nitride nanotube (BNNT) reinforced hydroxyapatite (HA) as a novel composite material for orthopedic implant applications. The spark plasma sintered (SPS) composite structure shows higher density compared to HA. Minimal lattice mismatch between HA and BNNT leads to coherent bonding and strong interface. HA-4 wt% BNNT composite offers excellent mechanical properties—120% increment in elastic modulus, 129% higher hardness and 86% more fracture toughness, as compared to HA. Improvements in the hardness and fracture toughness are related to grain refinement and crack bridging by BNNTs. HA–BNNT composite also shows 75% improvement in the wear resistance. The wear morphology suggests localized plastic deformation supported by the sliding of outer walls of BNNT. Osteoblast proliferation and cell viability show no adverse effect of BNNT addition. HA–BNNT composite is, thus, envisioned as a potential material for stronger orthopedic implants.

1. Introduction

Hydroxyapatite (HA) possesses chemical composition ($Ca_{10}(PO_4)_6(OH)_2$), crystal structure and Ca:P ratio (1.67) similar to apatite found in human skeleton (Gu et al., 2002; White et al., 2007; Yu et al., 2003). These features have made HA clinically accepted orthopedic implant material. In spite of its bioactivity, the poor fracture toughness and wear resistance of HA limits its application in load bearing orthopedic implants. Mechanical and tribological performance of HA could be improved by following two different approaches—grain size refinement and second phase reinforcement.

Researchers have successfully used nanocrystalline HA for the improvement of mechanical property without having negative effect on its biocompatibility (Li et al., 2007; Guo et al., 2007; Que et al., 2008; Grossin et al., 2009; Wang and Shaw, 2009; Wang et al., 2009). A recent study by Wang and Shaw (2009) has shown that grain size refinement

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