Mechanical properties and biomedical applications of a nanotube hydroxyapatite-reduced graphene oxide composite

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A B S T R A C T

As a result of the growing interest in the biological and mechanical performance of hydroxyapatite (HA)–graphene nano-sheets (GNs) composite systems, reduced graphene oxide (rGO) reinforced hydroxyapatite nano-tube (nHA) composites were synthesized in situ using a simple hydrothermal method in a mixed solvent system of ethylene glycol (EG), N,N-dimethylformamide (DMF) and water, without using any of the typical reducing agents. The consolidation process was performed by hot isostatic pressing (HIP) at 1150 °C and 160 MPa. The composites were characterized by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) and Raman spectroscopy, enabling confirmation of the synthesis and reduction of the nHA and rGO, respectively. The structure of the synthesized powder and cell attachment on the sintered sample was confirmed by field emission scanning electron microscopy (FESEM). The effects of the rGO on the mechanical properties and the in vitro biocompatibility of the nHA based ceramic composites were investigated. The elastic modulus and fracture toughness of the sintered samples increased with the increase of the rGO content when compared to the pure nHA by 86% and 40%, respectively. Cell culture and viability test results showed that the addition of the rGO promotes osteoblast adhesion and proliferation, thereby increasing the biocompatibility of the nHA–rGO composite.

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1. Introduction

Research in biomaterials is a rapidly growing field due to its direct relationship to human health [1]. Currently, the largest consumer market for biomaterial products is orthopedic biomaterials. Consequently, development and improvements to orthopedic biomaterials is an active and expanding research
HA nano-wire/nano-tube ordered arrays and fabrics exhibit similar structures as natural hard tissues and may be useful in biomedical research areas.

4. Conclusions

To summarize, composites of nHA and rGO powder were synthesized in situ using a hydrothermal method. A consolidation procedure was performed by HIP at of 1150 °C and 160 MPa. Compared to the pristine nHA, the composites show improvements in both their biological and mechanical properties. The results indicate that the elastic modulus and fracture toughness of the sintered samples increased by 86% and 40%, respectively, with increasing rGO content, compared to nHA. The cell culture and viability test results show that the addition of the rGO promoted osteoblast adhesion and proliferation. The biocompatibility of the nHA-rGO composite for different cell culture times may be enhanced by increasing the rGO content.

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