Preparation of Hydroxyapatite-Polyethylene Biocomposites Using HA-nanoparticles by Mechanically-Coating Method

Sukasem Kangwantrakool*

School of Ceramic Engineering, Institute of Engineering, Suranaree University of Technology, Nakhon Ratchasima 30000, Thailand

**Corresponding author. E-mail: sukasemk@yahoo.com*

ABSTRACT

New preparation routes have been investigated for enhancing mechanical properties of a biocomposite prepared with high-density polyethylene (HDPE) reinforced with hydroxyapatite (HA). HA nanoparticles, having mean particle size of 200 nm, were employed as fine particles to coat each coarse particle of HDPE with an elliptical-rotor-type mixer and with a high-speed rotational impact blending machine. The effects of the particle size of HDPE and the mixing conditions were studied on mechanical properties of the composite material, such as the rotor speed, the total treatment time, the number of preparation steps and the total volume fraction of HA. In comparison, it was found that the embedment besides uniform coating and dispersion of HA nanoparticles onto the surface of HDPE core particle was easily achieved by rotational impact blending due to high impact energy to yield the relatively high properties. Nevertheless, due to the slight embedment of fine particles by gentle shear and compressive stress, HA nanoparticles could not disperse uniformly due to aggregates generated by the molten HDPE of core particles esceping through the thick and loose coating layer during material formation which results in weak bonding among coated particles to yield lower mechanical properties.

Key words: Nanoparticles, Rotational impact blending, Elliptical-rotor-type mixer, Biocomposites, Coated particle

INTRODUCTION

High-density polyethylene (HDPE), reinforced with hydroxyapatite (HA), is one of the biocomposite materials which has been developed since early 1980s as an analogue for bone replacement. Bonfield et al., (1981) employed HA particles of 10–40 % by volume dispersed in HDPE matrix by means of a twin-screw extruder as a macroscopic mixing method. It was demonstrated that an optimum combination of mechanical and biological performance was achieved with the composite containing HA of 40% by volume (Bonfield, 1988). Such a composite has a modulus value approaching to that of cortical bone, superior toughness and considerably high bioactivity. The close modulus matching of the composite is promising to solve the problem of implants produced with conventional materials which have much higher modulus values than the bone. Implants made of the HA/HDPE composites encouraged bone apposition rather than fibrous encapsulation, which was encountered with other implant materials (Tanner et al.,1994). Recent progress in hydrostatic extrusion of HA/HDPE has indicated that composites with higher modulus (Young's as well as flexural modulus) and strength within the bounds of cortical bone can be manufactured for major load-bearing skeletal implants (Wang et al., 1997). Various aspects of HA/HDPE composites have been investigated since their invention. One particular topic of great interest is the mechanical properties of