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Effect of various shaped magnesium hydroxide particles on mechanical and biological properties of poly(lactic-*co*-glycolic acid) composites

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ABSTRACT

Five different shapes of magnesium hydroxide ($Mg(OH)_2$) particles (Plate-S, Plate-N, Disk, Whisker, and Fiber) were synthesized and added to biopolymer (i.e., Poly(lactic-co-glycolic acid) (PLGA)) composite to improve their mechanical and biological properties. The PLGA composite films including $Mg(OH)_2$ particles were prepared by a solvent casting method. Their mechanical and biological properties were compared according to the composites containing different shapes of $Mg(OH)_2$ particles. Among them, the fiber shape of $Mg(OH)_2$ provided the highest mechanical strength, and anti-inflammation and anti-bacterial activity to PLGA films among other forms. This study demonstrated a new strategy for the design of biomaterials by controlling the form of inorganic additives.

Introduction

Many types of biodegradable synthetic polymer have been widely used in the biomedical field. Especially, biodegradable polymers based implants play an important role to replace or recover the damaged parts within human body due to their long-term biocompatibility. Generally, biodegradable polymers with polyester structures can be degraded by hydrolysis and the degradation products are metabolized in the body through Krebs cycle [1–4]. Among aliphatic polyesters, poly(lactic-*co*-glycolic acid) (PLGA) has attracted considerable interest use in stent and drug delivery due to its biodegradability and biocompatibility [4–8]. However, PLGA limits its use as stent backbone because of their relatively low mechanical properties compared to synthetic polymers. Also, it is known to trigger chronic inflammation and cell death due to foreign body reaction composed of macrophages and foreign body giant cells [9,10]. The nonspecific hydrolytic decompositions of PLGA produce acidic environment that may cause non-infectious inflammatory response in human body [10–12]. Therefore, several studies have been attempted to improve the mechanical properties and reduce the inflammatory responses of aliphatic biodegradable polymers [11–15].

Magnesium hydroxide ($Mg(OH)_2$) is an excellent biocompatible inorganic material with anti-bacterial activity [16]. These $Mg(OH)_2$ particles are degraded in the body and become magnesium which is an essential mineral for human metabolism (the adult human body contains from 21 to 28 g of magnesium) and linked to various pathological conditions [17]. Moreover, these $Mg(OH)_2$ are also well known as pH neutralization agents. The acidic environments produced by PLGA degradation i.e., lactic and glycolic acid, can be neutralized by adding $Mg(OH)_2$ [12–14]. In the case of adding inorganic particles without surface modification to the polymer matrix, the mechanical strength of the polymer composites decreased due to their low interfacial strength between matrix and inorganic particles which increase defects. Thus, the surface modification of $Mg(OH)_2$ with size control has been actively researched in the past few years [12,13,15]. However, the morphological comparison of $Mg(OH)_2$ particles when used as an additive to polymer composites is still insufficient.

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