A Poly(lactide) Stereocomplex Structure with Modified Magnesium Oxide and Its Effects in Enhancing the Mechanical Properties and Suppressing Inflammation

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1. Introduction

Since the synthesis of polylactide by Carothers at DuPont in 1932, many researchers have studied polyester polymers such as polylactide, polyglycolide, and polycaprolactone. Biodegradable polymers such as poly(l-lactide) (PLLA) have been widely utilized as materials for biomedical applications. However, the relatively poor mechanical properties of PLLA and its acid-induced cell inflammation brought about by the acidic byproducts during biodegradation pose severe problems. In this study, these drawbacks of PLLA are addressed using a stereocomplex structure, where oligo-D-lactide-grafted magnesium hydroxide (MgO-ODLA) is synthesized by grafting D-lactide onto the surface of magnesium hydroxide, which is then blended with a PLLA film. The structure, morphology, pH change, thermal and mechanical properties, in-vitro cytotoxicity, and inflammation effect of the MgO-ODLAs and their PLLA composites are evaluated through various analyses. The PLLA/MgO70-ODLA30 (0–20 wt%) composite with a stereocomplex structure shows a 20% increase in its tensile strength and an improvement in the modulus compared to its oligo-L-lactide (PLLA/MgO70-OLLA30) counterpart. The interfacial interaction parameter of PLLA/MgO70-ODLA30 (5.459) has superior properties to those of PLLA/MgO70-OLLA30 (4.013) and PLLA/Mg(OH)2 (1.774). The cell cytotoxicity and acid-induced inflammatory response are suppressed by the neutralizing effect of the MgO-ODLAs. In addition, the inflammatory problem caused by the rapid acidification of the stereocomplex structure is also addressed. As a result, the stereocomplex structure of the MgO-ODLA/PLLA composite can be used to overcome the problems associated with the biomedical applications of PLLA films.

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