INVESTIGATION OF INITIAL DEGRADATION STAGE AND TENSILE STRENGTH OF POLYLACTIDE AND ITS COMPOSITES WITH EGGSHELLS

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Introduction

Many research centres try to investigate new biocomposites for different purposes, contain materials from natural resources [1]. Polylactide (PLA) is a very popular biodegradable aliphatic polyester, which can act as an alternative to other polymers [2]. Its degradation rate depends on porosity, crystallinity, initial particle size and amount of additives [1]. What is more, bioadditives can also influence mechanical properties of polymer [3]. Natural bone is resistant to different stresses due to complex construction of inorganic and organic elements [4,5]. It inspires to design similar materials. The paper focuses on investigating tensile strength and the initial stage of degradation of polylactide and its composites with particles obtained from eggshells. Both of components are biodegradable, so testing their combination allows to consider the composite for application in an eco-friendly packing or medical material with mechanical properties comparable to natural [2,6,7]. Described tests introduce new results in the field of degradation and modification of polylactide with natural particles.

Materials and Methods

As a matrix of composites, technical polylactide unsuitable for natural body (Ingeo, Natureworks) was used. As a filler, particles of eggshells were prepared. Firstly, eggshells were washed, dried in an oven in 100ºC for 30 min and ground in electric grinder to the powder. Then they were stirred in 14.5% NaOH solution to remove organic parts, washed with distilled water, dried, then stirred in pure methanol for 30 min, decanted, washed with distilled water and dried. Polylactide was also dried in an oven in 50ºC to achieve constant weight. Three types of samples were prepared using Zamak Mercator injection machine: pure PLA, PLA with 10% eggshells [EG] and PLA with 20% of eggshells. Degradation of samples was tested in two different environments: distilled water and simulated body fluid (SBF), in 37ºC for a one month. Samples were mixed with solutions with mass ratio 1:10, each type separately. During this time, pH and electrolytic conductivity of solutions, in which samples were put, were investigated. What is more, tests were also performed for solutions without PLA and its composites in it. Mass of samples was tested regularly, both after soaking with solution and then drying it to constant mass, so solution absorptivity could be calculated. The surface of samples before and after degradation was observed using NOVA NANO SEM 200 microscope with EDS. Added eggshells were also investigated to determine their composition. Tensile strength and Young's modulus were tested on universal testing machine Zwick 1435, both before degradation and after one week.

Results and Discussion

FIG. 1. Samples after tensile test.

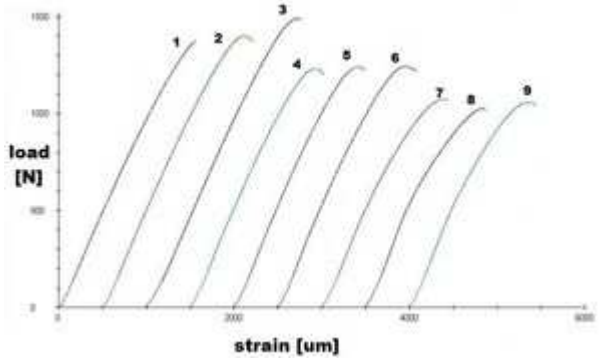

FIG. 2. Load-strain characteristics of tensile test for all types of samples (1-3: pure PLA, 4-6: PLA+10%EG, 7-9: PLA+20%EG).

From tensile test it could be observed that for non--degraded samples, Young's modulus increases and tensile strength decreases with the increase of the amount of EG additive. Absorptivity of solution by materials could be observed to a small extent. Conductivity and pH of solutions was changing irregularly differently according to the type of material. Observation on SEM with EDS of EG allowed to conclude about the influence of modification on it, and tested samples - about the influence on degradation on the surface.

Conclusions

Combination of PLA with particles of modified eggshells is a promising solution in the area of biodegradable composites. The advantage of this is availability of additive and interesting properties, which can be altered by changing the amount of EG.

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