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Assessment of the Change in Strength Properties of Biocomposites Based on PLA and PHA after 4 Years of Storage in a Highly Cooled Condition

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Abstract : Polylactides (PLA) and polyhydroxyalkanoates (PHA) are the two groups of biodegradable and biocompatible thermoplastic polymers most commonly utilised in medicine and rehabilitation. The aim of this work is to determine the changes in the strength properties and the microstructures taking place in biodegradable polymer composites during their long-term storage in a highly cooled environment (i.e. a freezer at -24ºC) and to initially assess the durability of such biocomposites when used as single-use elements of rehabilitation or medical equipment. It is difficult to find any information relating to the feasibility of long-term storage of technical products made of PLA or PHA, but nonetheless, when using these materials to make products such as casings of hair dryers, laptops or mobile phones, it is safe to assume that without storing in optimal conditions their degradation time might last even several years. SEM images and the assessment of the strength properties (tensile, bending and impact testing) were carried out and the density and water sorption of two polymers, PLA and PHA (NaturePlast PLE 001 and PHE 001), filled with cellulose fibres (corncob grain – Rehofix MK100, Rettenmaier&Sohne) up to 10 and 20% mass were determined. The biocomposites had been stored at a temperature of -24ºC for 4 years. In order to find out the changes in the strength properties and the microstructure taking place after such a long time of storage, the results of the assessment have been compared with the results of the same research carried out 4 years before. Results shows a significant change in the manner of fractures – from ductile with developed surface for the PHA composite with corncob grain when the tensile testing was performed directly after the injection into a more brittle state after 4 years of storage, which is confirmed by the strength tests, where a decrease of deformation is observed at point of fracture. The research showed that there is a way of storing medical devices made out of PLA or PHA for a reasonably long time, as long as the required temperature of storage is met. The decrease of mechanical properties found during tensile testing and bending for PLA was less than 10% of the tensile strength, while the modulus of elasticity and deformation at fracturing slightly rose, which may implicate the beginning of degradation processes. The strength properties of PHA are even higher after 4 years of storage, although in that case the decrease of deformation at fracturing is significant, reaching even 40%, which suggests its degradation rate is higher than that of PLA. The addition of natural particles in both cases only slightly increases the biodegradation.

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