Abstract of PhD Thesis

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"Investigation of biobased polyesters compositions in design of biodegradable engineering materials for agriculture use"

Plastics in agriculture and horticulture are used to make pots, mulch films or tunnel coverings, to improve the quality of agricultural products, protect crops and allow fruit and vegetables to grow out of season. Commonly used in such applications are so-called conventional plastics, usually polyolefins. These are very durable and inexpensive materials, but products made from them for agriculture and horticulture are difficult to recycle due to organic pollutants that prevent material recycling. Polyolefins, to which we include polyethylene and polypropylene, also do not have the capacity to fully biodegrade, so this solution generates a lot of waste and contributes to increased environmental pollution. In the era of sustainable development, products made from biodegradable plastics can increasingly be found in many areas of life, which are slowly displacing the use of conventional plastics. The use of biodegradable polyesters is a pro-ecological alternative, has been implemented for years at the Lodz University of Technology, among others, in the framework of the key project "Biodegradable fiber products" (acronym: Biogratex) of POIG. 01. 03.01.00-0.

The research presented in this doctoral thesis focused on the analysis of the properties of selected bio-derived polyesters - such as PLA, BioPBS, PHA and PBAT - in the development of innovative biodegradable engineering materials with potential applications in agriculture and horticulture. For this purpose, novel polymer compositions based on these bio-derived polyesters were prepared and then the conditions for the formation of nonwoven structures by the pneumothermic (meltblown) method were developed.

In the first stage of the research, the conditions for the formation of nonwovens made from BioPBS were developed. Nonwovens were subjected to a full analysis of the microstructure, surface characteristics and physical properties. The results of the research led to the formulation of boundary conditions of the technological process of forming nonwovens with BioPBS, and to determine the properties of the obtained structures. This research formed the basis for further work on materials produced from BioPBS, including polymer compositions based on this plastic.

In the second stage, conditions for the formation of seedlings were developed by pneumothermic method based on BioPBS and polymer compositions BioPBS with PHA, BioPBS with PBAT and also as reference from PLA. In addition to metrological characterization, the produced pots were subjected to degradation in two different environments: hydrolytic degradation in laboratory conditions and biodegradation in soil under field conditions. Instrumental evaluation of the degradation effects of the developed prototype products for agriculture and horticulture made it possible to understand the kinetics of the process especially in the case of the proposed polymer compositions and beyond the mechanisms of degradation including structural changes especially at the supramolecular level.

In the field experiment degradation was carried out in a simulated process of plant cultivation of celery, which allowed to preliminary estimate the impact of the proposed material innovations on crop yield and plant development and provides prospects for interesting research not only in the field of materials engineering but also in environmental engineering, agriculture and horticulture.