THERMOPHYSICAL AND MECHANICAL PROPERTIES OF FILMS BASED ON DEGRADABLE POLYMERS

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Due to increasing pollution of the environment, humans have been faced with the task of minimizing or completely removing their waste products. This problem can be overcome by introducing degradable polymers into various areas of human life. Examples of such materials are polycaprolactone (PCL) and L-isomer of polylactide (PLA-L). The goal of this work is to produce thin films from PCL, PLA-L, and additionally from PVA, with subsequent testing of their thermal and mechanical properties.

The PCL and PLA-L films were prepared by hot-compaction method i.e. pressing polymer granules above melting temperature in a steel mold with Teflon substrate. Due to the proximity of the melting and decomposition temperature of PVA, the third type of film was prepared by an aqueous solution method with a 3 wt.% polymer concentration in the solution. The thickness of prepared films was in the range of 100–150 mcm. Testing of thermal properties was conducted with the equipment by TA Instruments, USA, namely DSC: heating/cooling rate was 20 °C/min, and TGA: up to 700 °C, heating rate was 20 °C/min under air atmosphere. Mechanical characteristics (stress-strain diagram) were obtained on Shimadzu tensile machine, Japan (tensile speed was 5mm/min). The parameters of the obtained experimental curves are listed in Table 1.

Table 1. Parameters of the films based on PCL, PVA, and PLA-L

		PCL	PVA	PLA-L
Stress–strain diagram	Young's modulus (GPa)	0,15	3,49	2,90
	Yield stress (MPa)	4,48	73,49	40,00
	Tensile strength (MPa)	7,56	51,73	39,79
	Elongation at break (%)	115,19	20,79	1,79
Thermogravimetric analysis (TGA): the temperature at different weight loss	95 % weight (°C)	329	203	327
	90 % weight (°C)	346	252	337
	75 % weight (°C)	377	281	352
	50 % weight (°C)	399	319	364
Differential scanning calorimetry (DSC)	Degree of crystallinity (%)	29,0	30,7	42,0
	Glass transition temperature (°C)	-	-	62
	Melting temperature (°C)	52	228	171

A set of thermal and mechanical characteristics of prepared films based on PLA, PCL, and PVA demonstrates the possibility of using such films as packaging materials. The highest mechanical strength is shown by PVA and PLA films, which is combined with low elasticity. At the same time, PCL has low strength, but high elasticity. As a result, the latter can be used as a modifying additive for PLA, improving its technological and mechanical characteristics. TGA results show high thermal stability of the produced films.