

# BIODEGRADABLE BINARY BLENDS OF POLYLACTIDE AND POLYCAPROLACTONE

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## Introduction

Biodegradable aliphatic polyesters like polylactide (PLA) and polycaprolactone (PCL) are widely used in many biomedical applications, including tissue engineering, drug delivery and implant coatings [1,2]. PCL is known for its rubbery characteristic with high elongation at break and for slow biodegradation rate, while PLA is a polymer with high tensile strength and modulus, as well as slower degradation rate. Their properties are complementary, hence they constitute promising blending partners. Polymer blending is a modification technique that allows to combine properties of different polymers or to develop unique features. It is a physical process, thus it does not change the chemical fingerprint of the components, but it can enhance their performance [3].

The aim of this preliminary work was to produce and characterize binary blends of polylactide and polycaprolactone for further use in blood vessels engineering.

## Materials and Methods

Two different solvents (Avantor Performance Materials Poland S.A.) were used to prepare initial PLA (IngeoTM 3051D, Nature Works LCC) and PCL (Sigma-Aldrich, Mn = 80 000) solutions – dichloromethane and dimethylformamide in proportion 3:1:

- PLA10 (10% w/v PLA),
- PCL10 (10% w/v PCL),
- PLA15 (15% w/v PLA),
- PCL15 (15% w/v PCL).

Samples of 1:0, 1:1, 1:3, 0:1 (PLA:PCL) blends were prepared by solvent blending and casted into films. Digital microscopy, differential scanning calorimetry (DSC), X-ray diffraction (XRD), water contact angle, and tensile tests were used to investigate the structure, morphology and properties of the PLA/PCL binary blends.

## Results and Discussion

X-ray diffraction patterns showed sharp crystalline peaks for both pristine polymers (at 16.6°, 19.1° and 22° for PLA, and at 21° and 23.8° for PCL) with lower intensity for lower concentration solutions. Similar peak positions were observed in blend samples, what indicates immiscibility of the two polymers.

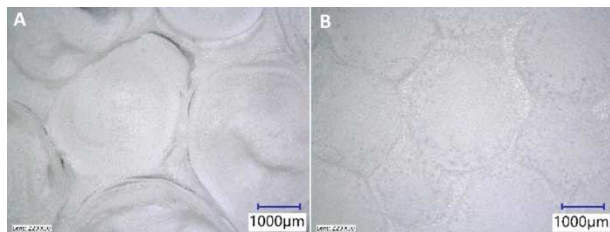


FIG. 1. Digital microscope images of PLA10:PCL15 (A) 1:1 and (B) 1:3.

Also microscopic observations (FIG. 1) and DSC thermograms (FIG. 2) confirmed their immiscibility – in all the blend samples double glass transition temperatures were present. For pristine polymers  $T_g$  varied depending on solution concentration: 11.88°C vs. 22.51°C in the case of PLA10 and PLA15, respectively and -59.78°C vs. -56.76°C for PCL10 and PCL15. Moreover, two independent melting peaks corresponding to PCLy (at 62°C) and PLAx (at 169°C) were noted. Blending of PLAx with PCLy resulted in decrease in crystallinity of polylactide component, even up to 31% when higher concentration PCL was added in higher fraction (i.e. PLA10:PCL15 1:3).

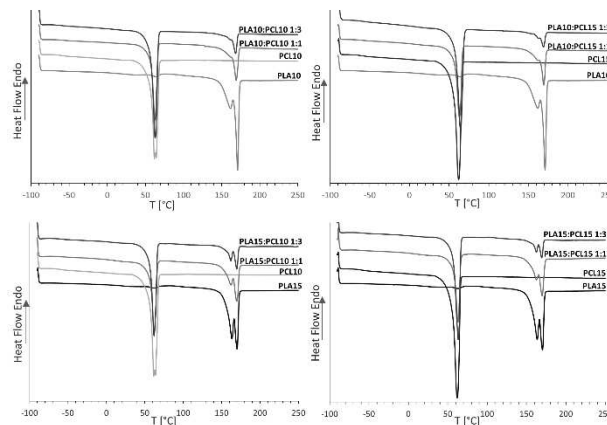


FIG. 2. DSC thermograms of pristine polymers and their blends.

Tensile test revealed that mechanical properties change along with various blend compositions. Pristine PLA is a high strength but brittle material, while PCL is ductile material with high elongation at break. That is why blends with higher PCL content exhibited higher elongation, but lower tensile strength and Young's modulus in comparison to pure PLA.

## Conclusions

Blending alters physical properties of the parent polymers, depending on the amount of each polymer. PLA and PCL are immiscible; their blending allows to tailor some tunable properties like crystallinity and mechanical parameters.

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## References

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