polymers

MDPI

*Supplementary Materials*

# Investigation of the Effects of Chain Extender on Material Properties of PLA/PCL and PLA/PEG Blends: Comparative Study between Polycaprolactone and Polyethylene Glycol

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## 1. Phase Morphology

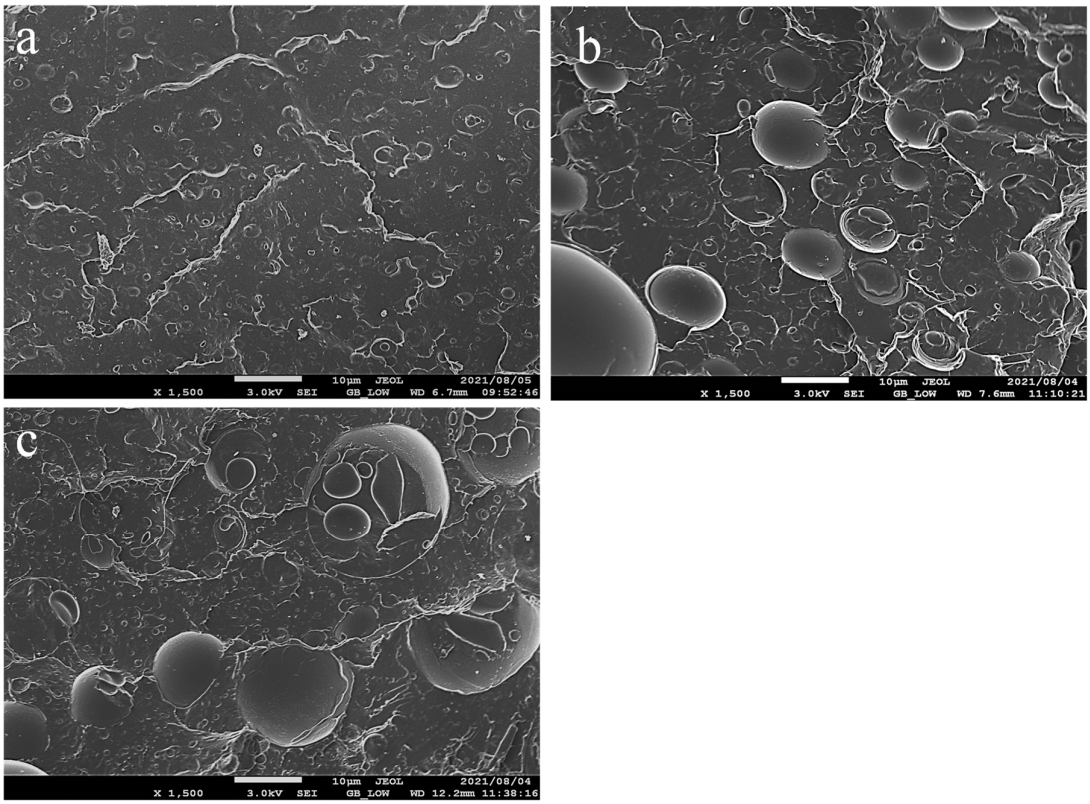


**Figure S1.** SEM images of the cryogenically fractured surface morphologies of (a) PLA/PCL 80/20, (b) PLA/PCL 70/30, and (c) PLA/PCL 60/40.

**Figure S1** shows the cryogenically fractured surface morphologies of PLA/PCL blends with varying PCL content at 20, 30, and 40 wt.%. This figure shows a matrix-dispersed morphology, where PCL droplets are dispersed in a continuous PLA matrix. In

**Figure S1(a)**, with the addition of 20 wt.% PCL, the image shows that small PCL droplets are heterogeneously distributed within the PLA matrix. However, when the PCL content is increased to 30 wt.%, the coalescence of PCL droplets is observed within the PLA matrix as shown in **Figure S1(b)**. Therefore, it shows a better distribution of PCL droplets dispersed within the continuous PLA matrix. In **Figure S1(c)**, the size of PCL droplets increased with 40 wt.% of PCL, showing a large droplet size. Overall, PLA/PCL 70/30 wt.% shows a good morphology with better distribution of PCL droplets. The matrix-dispersed morphology increases the toughness of PLA as the primary polymer within the blend.

**2. Mechanical Properties**

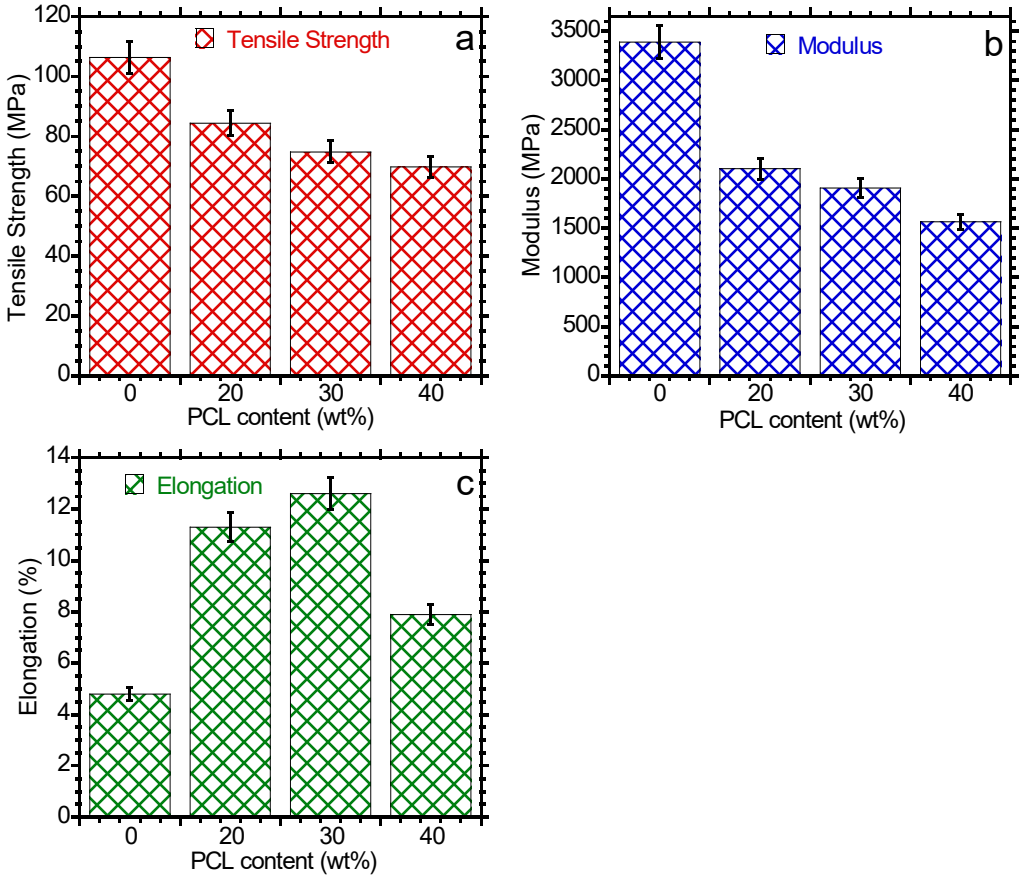


**Figure S2.** Mechanical properties of PLA/PCL blends: (a) tensile strength, (b) modulus, and (c) elongation.

PLA has a good potential to replace conventional polymers. However, it still suffers from high brittleness. Therefore, blending it with ductile polymers is reported to be a promising method to reduce the brittleness. The mechanical properties of the PLA/PCL blends studied are shown in **Figure S2**. The tensile strength of the PLA/PCL blends is shown in **Figure S2(a)**. It is observed that the tensile strength of PLA decreases with increasing PCL content. **Figure S2 (b) shows** the tensile modulus of PLA/PCL blends. This provides information about the stiffness of the material. The stiffness of the material decreased with increasing PCL content. In **Figure S2(c)**, the elongation-at-break is shown, indicating the toughness behaviour of the material. The elongation-at-break increased with the addition of 20 and 30 wt.%, showing an increase in the toughness of the material. However, when 40 wt. PCL was added to PLA, the toughness decreased compared to when 20 and 30 wt.% PCL were added. In summary, the addition of PCL to the PLA matrix

increases the elongation at break of the PLA, indicating a greater toughness of the material with 30 wt.% proving to be enough to improve the toughness of the PLA.

## 3. Conclusions

The study investigated PLA/PCL blends containing 20, 30, and 40 wt.% PCL content. The results showed that the PCL content influenced the final morphological behaviour of the material, with 30 wt.% of PCL showing a better distribution of PCL droplets. The mechanical properties of the blends show that 30 wt.% PCL is enough to increase the toughness of the material. These results proved to be enough to give knowledge in choosing the optimum blend.