

Title : Development of Poly(ϵ -caprolactone) and Poly(L-Lactide-co- ϵ -caprolactone) to Improve Mechanical and Thermal Properties for Artificial Cartilage Applications.

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ABSTRACT

Materials used for artificial cartilage must possess appropriate mechanical and thermal properties, ensuring both strength and flexibility. Poly(ϵ -caprolactone) (PCL) has great potential for artificial cartilage development due to its high flexibility, softness, and excellent biocompatibility. However, its low mechanical strength and thermal properties necessitate modifications to enhance its suitability for such applications. Poly(L-lactide-co- ϵ -caprolactone) (PLCL) combines the mechanical strength of Poly(L-lactide) (PLLA) with the flexibility of PCL, resulting in an optimal balance of strength and flexibility. Therefore, this study aims to enhance the mechanical and thermal properties of PCL and PLCL by incorporating poly(ethylene glycol) (PEG) as an additive at concentrations of 0.1, 0.3, and 0.5%w/w. The study analyzed the mechanical properties were evaluated through tensile testing, while viscosity was measured using the dilute solution viscosity technique. Thermal properties were analyzed using Differential Scanning Calorimetry (DSC). The study found that adding 0.3%w/w of PEG to PLCL effectively enhances its mechanical and thermal properties. This is due to its balanced mechanical strength and flexibility, which are crucial for cartilage replacement materials. Based on the analysis, the Young's modulus was measured at 231.14 MPa, a moderate value that provides both flexibility and sufficient strength to support weight. The elongation at break was 76.37%, indicating that the material can withstand tensile and compressive forces without becoming brittle. The tensile strength was 8.064 MPa, which is comparable to natural cartilage, which ranges from 5–25 MPa. Additionally, the inherent viscosity was 1.36 dL/g, which is within an optimal range that maintains both strength and flexibility. For thermal properties, the glass transition temperature (T_g) was 19.22 °C, the crystallization temperature (T_c) was 113.33 °C, and the melting temperature (T_m) was 156.33 °C. The T_g value is lower than to body temperature, ensuring that the material remains flexible under physiological conditions. These results suggest that PLCL with 0.3%w/w PEG exhibits improved mechanical and thermal properties, making it a promising candidate for artificial cartilage applications.