Phase Behavior and Morphology of Biodegradable Poly(ε-caprolactone)/Propylene Carbonate Blends

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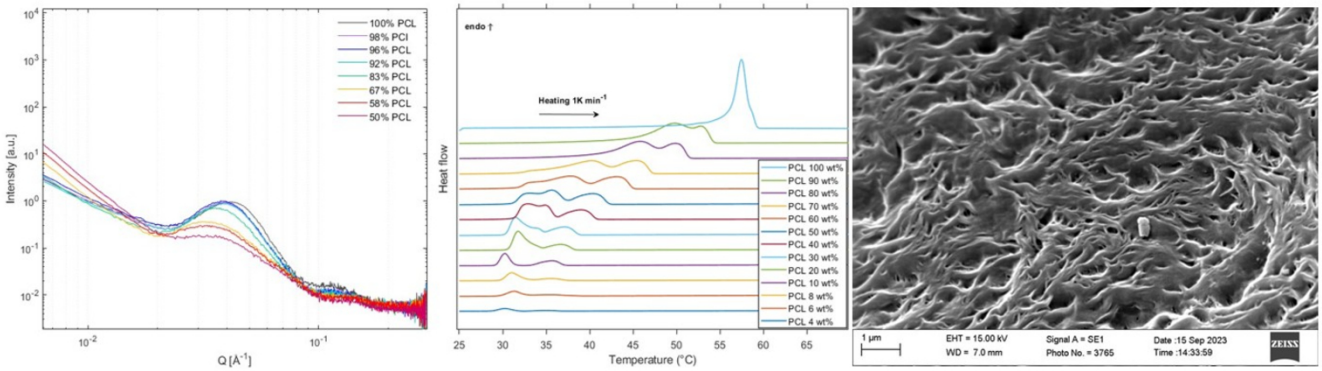
Microplastic pollution is an increasing environmental concern, driving interest in biodegradable polymer materials as sustainable alternatives [1]. Porous polymers are of particular interest because their internal structure strongly influences degradation behaviour and potential functional performance [2,3]. In this work, the structure and morphology of poly(ε-caprolactone) (PCL)/propylene carbonate (PC) blends were studied by differential scanning calorimetry (DSC), simultaneous small- and wide-angle X-ray scattering (SAXS/WAXS), polarised light optical microscopy (PLOM), and scanning electron microscopy (SEM) imaging, using PCL as a model biodegradable semicrystalline polyester [4,5]. Across compositions, changes in melting and crystallization behaviour were observed, indicating that the addition of a solvent affects the crystallization of PCL and modifies the resulting structure. SEM imaging revealed the development of porous morphology, consistent with phase separation during cooling and crystallization, where polymer-rich and solvent-rich domains give rise to voids or sponge-like structure. An increase in polymer crystallinity, when normalized to the polymer fraction, was also observed with increasing PC content, suggesting that PC may enhance the ability of PCL chains to reorganize during crystallization and thus promote structural ordering within the polymer-rich phase. SAXS/WAXS measurements suggested composition-dependent changes in the scattering profile, with variations in the low-q region potentially associated with porosity development and shifts in the correlation peak position possibly reflecting lamellar reorganization [6]. The combined results suggest that the addition of PC strongly influences both the meso- and nanoscale morphology of PCL, leading to altered thermal response and the formation of heterogeneous porous structure.

Keywords:
biodegradable; porous; differential scanning calorimetry; polycaprolactone; propylene carbonate, small and wide-angle X-ray scattering.



SAXS profiles (left) and DSC heating thermograms (middle) reveal changes in nanoscale organization and melting behavior with increasing PC content. SEM imaging (right) shows the development of a porous, sponge-like structure..

References:

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