Lipase-mediated degradation of poly-ε-caprolactone in toluene: Behavior and its action mechanism

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ABSTRACT

Lipase-catalyzed hydrolysis of poly(e-caprolactone) (PCL) in toluene was investigated. PCL with number-average molecular weight ($M_n$) 10,000 g mol$^{-1}$ was hydrolyzed using immobilized Candida antarctica lipase B (CALB). The increase in PCL concentration led to a decrease in degradation rate. Enhanced rate was observed when reaction temperature was increased from 30 to 50 °C. Enzymatic chain scission of PCL yielded cyclic dicaprolactone, tricaprolactone, tetracaprolactone and oligomers with $M_n$ less than ~1000 g mol$^{-1}$. Catalytic formation of cyclic lactones via back-biting mechanism in low water content environment was attributed to CALB. Its hydrolysis of PCL displayed consecutive random- and chain-end scission with time from detailed thermal, molecular weight and structural analyses. Apparent activation energy, $E_a$ for hydrolysis was 45 kJ mol$^{-1}$ i.e. half of that reverse reaction. Dicaprolactone and oligomers from hydrolysis readily re-polymerized to produce mid-range polymer with $M_n$ 1400 g mol$^{-1}$ after 36 h in the same reaction medium.

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1. Introduction

Excellent progress has been made in the application of solvent is a promising route in improving reaction kinetic, increasing the yield of degradation products and ease in products separation compared to aqueous mixture [10,15]. More impor-