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PROCESSING AND ELONGATIONAL DEFORMATION BEHAVIOR OF BIAXIALLY STRETCHED POLYLACTIC ACID (PLA) FILMS

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While major endeavors have attempted to study and understand how the interesting biodegradable polylactic acid (PLA) can be practically utilized, one critical issue for research and development still lies in its processing technology. In this study, an emphasis is on biaxial film stretching process of PLA, in particular the common sequential stretching mode. Sequential biaxially oriented PLA (BOPLA) films prepared under controlled deformation rates and ratios, and in its rubbery state (~75-85 ℃) reveal interesting deformation behaviors and various resulting film properties in terms of gas permeability, optical and mechanical properties. In general, produced BOPLA films are optically clear. Films of ~20 μm thick, posses reasonably low oxygen transmission rates (OTR) in a range of 1,000 cc/m^2.day.atm. However, in this study, high performance BOPLA film with an approximately four-fold increase in OTR can be effectively developed. Such an improvement in OTR of BOPLA film is obtainable solely under specific processing conditions or by defined deformation ratios and rates, both in MD and TD stretching. For instance, BOPLA films (~20 μm thick) with 4x4.5 (MDxTD) stretch ratios, possess OTR of ~4,000 cc/m^2.day.atm. Obviously, deformation behavior of PLA film in the second stretching (TD) depends primarily upon the structure (crystallinity and orientation) developed in the first stretching (MD). By varying key processing parameters in both MD and TD stretching (e.g., deformation rate, ratio, and temperature), systematic data indicating elongational deformation behaviors of BOPLA under different conditions can be established. Based on observed deformation characteristics, there exist certain processing conditions, where imparted stress and strain can lead to specific structural development in BOPLA film giving rise to enhanced gas permeability. In this paper, structural development under elongational deformation in film biaxial stretching process will be discussed by taking PLA's unique material properties (e.g, thermal property and crystallization) into consideration.