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Crystallization behavior of PLLA/PDLA bicomponent fiber during annealing process

Nanjaporn Roungpaisan, Wataru Takarada and Takeshi Kikutani
Department of Materials Science and Engineering, Tokyo Institute of Technology

E-mail: Kikutani.t.aa@m.titech.ac.jp

Introduction

Islands-sea (I-S) bicomponent melting spinning, in which poly(D-lactic acid) and poly(L-lactic acid) were coextruded as islands and sea components, was utilized to directly produce the racemic poly(lactic acid) fibers.

Experimental

Both polymers have high optical purity of ≅ 99.5%. The I-S fibers with 1519 islands with the composition of 50:50 were successfully prepared at take-up velocities from 1 to 7 km/min. Extrusion temperature was 230°C.

Results and Discussion

Figure 1 shows the DSC thermograms of as-spun fibers. Cold crystallization peak became smaller, shifted to lower temperature, and disappeared with the increase of take-up velocity, while after the melting of α-form crystals (α-crystal), surprisingly melting of stereo-complex (SC) crystals was clearly observed. Based on this result, annealing process was applied to the as-spun fibers at 200 °C for 1 h, and the change of crystalline structure was traced through the WAXD measurement as shown in Figure 2. In the fiber spun at 6 km/min, which initially has α-crystals, development of SC-crystals was observed when the temperature reached the melting temperature of α-crystals (~ 165 °C). The amount of the SC-crystals slightly increased during annealing at 200 °C. In the cooling process, recrystallization of α-crystals occurred with higher intensity than the initial state while intensity of SC-crystals was constant as compared to at the end of the annealing process. It should be mentioned that the fibers maintained its shape after the annealing.

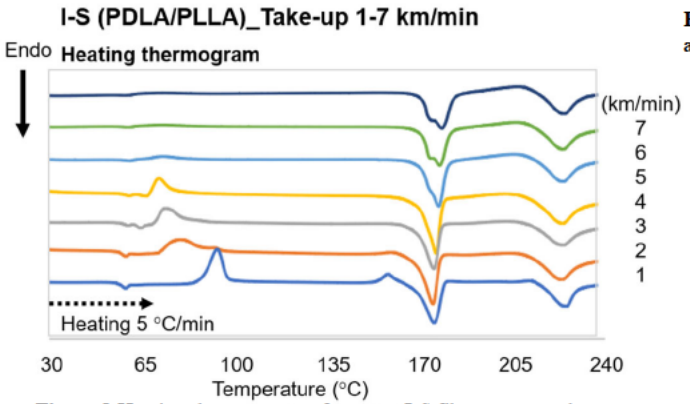


Figure 1 Heating thermograms of as-spun I-S fibers measured at heating rate of 5 C/min.

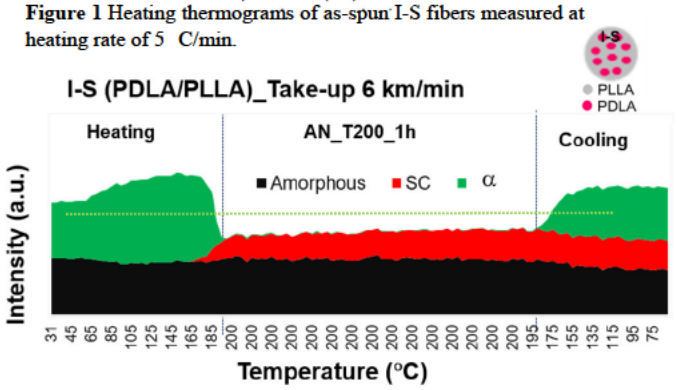
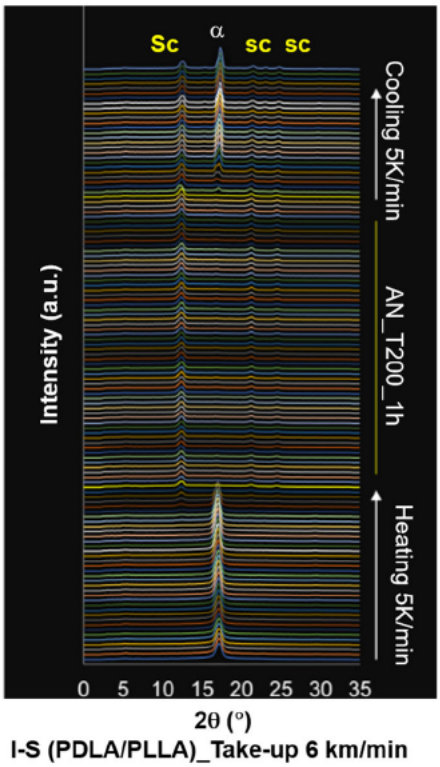


Figure 3. Variation of the amount of SC-crystal, α-form crystal, and amorphous phases with the change of temperature.

Figure 2 Variation of WAXD intensity during heating, annealing and cooling processes for 6 km/min fiber.



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