Polylactic acid (PLA), a bio-derived and biodegradable polymer, is currently being used for food packaging. However, more widespread usage is limited by PLA's poor water vapor barrier properties. A simple way to overcome this limitation is to incorporate nanoplatelets of high aspect ratio in the polymer, resulting in the formation of a nanocomposite. The nanofillers form impermeable barriers to mass transfer and cause the diffusing molecules to travel along a tortuous path, resulting in reduced permeability. To successfully implement this strategy, though, one needs to use only a limited amount of platelets but ensure that these are separated from each other and are uniformly distributed.

In this work, Cloisite™ 30B, an organically modified nanoclay, was dispersed in PLA, and operating conditions in an internal mixer were optimized to give the best barrier properties. Thin films were compression molded, and their morphology was examined with the help of transmission electron microscopy. Moisture permeability measurements were made with MOCON WVTR equipment, and it was found that permeability values decreased progressively as the content of Cloisite™ 30B was increased; at 10 wt% (5.3 vol%) loading, the water vapor permeability was reduced by 69% when compared to neat PLA.
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We also present the combined effect of crystallinity and nanoclay on barrier properties, and these show that the presence of crystallinity results in a further decrease in permeability. In addition, graphene nanoplatelets are used as barriers, and results are compared with those obtained with the use of nanoclay. A simple theory is presented to successfully predict the experimentally determined permeability results. This is perhaps the first time that such quantitative agreement has been demonstrated.

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