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Modification of iPP microcellular foaming behavior by thermal history control and nucleating agent at compressed CO_2

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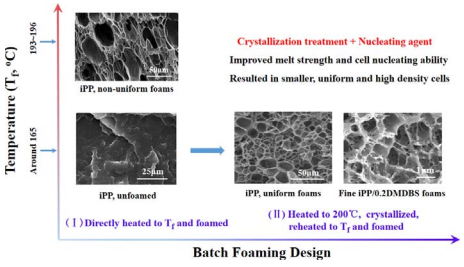
GRAPHICAL ABSTRACT



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ABSTRACT

This study is aimed at using thermal history control and nucleating agent to adjust the foaming behavior of isotactic polypropylene (iPP). Through the introduction of an annealing stage and α nucleating agent, the crystallization and rheological properties of iPP were changed, and its microcellular foaming behavior was tuned correspondingly. Rheological testing results verified the enhancement of melt strength through the presentation of the crystallization stage and α nucleating agent. After an annealing at 110 °C, 10 MPa, for 40 min, iPP was further saturated at 165 °C, 12 MPa for 30 min and then foamed, the cell density is 7.95×10^9 cells/cm^3, while the average cell size is 11.66 μm. Furthermore, the synergy between the annealing treatment and an addition of 0.2 wt.% α nucleating agent could positively affect the heterogenous cell nucleating ability and melt strength of iPP, much smaller sized cells with relatively quite high cell density up to 10^{13}–10^{14} cells/cm^3 were induced.

1. Introduction

Microcellular foams exhibit unique properties over solid or traditional foamed polymers, such as light weight, material saving, low heat conductivity, and high impact strength, these advantages enable microcellular foams to be received significant attentions in the past several decades [1–4]. Compressed CO_2 is usually used in microcellular foaming process, as a physical foaming agent, primarily because it is inexpensive and safe in performance [4]. Compared with other microcellular foamed polyolefin materials such as polystyrene (PS) or polyethylene (PE), Polypropylene (PP) foams have higher service temperature, rigidity and thermal stability. Additionally, PP foams offer a good impact strength than PS foams, and a higher strength than PE foams [5,6]. PP foams are the promising substitutes for other polyolefin thermoplastic foams in various industrial applications. Being one of universal synthetic polymer materials, iPP has been popularly applied in packaging, household appliances, heat insulating, automobile parts, and other industrial fields. However, iPP is difficult to be foamed to a fine cell morphology level. The main reason is ascribed to its liner molecular structure, which results in a too low melt strength and

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