Title: Processing-Dependent Polymer Chain Orientation In HDPE Pipes After Biaxial Drawing In The Solid-State

Main Author:

Name: Ralf Kleppinger
Organization: DSM Material Science & SABIC Technology Center Geleen
Country: The Netherlands

Co-Authors:

Co-author 1: Ajay Taraiya
Organization: Sabic Technology Center Geleen
Country: The Netherlands
Co-author 2:
Organization:
Country:
Co-author 3:
Organization:
Country:
Co-author 4:
Organization:
Country:
Co-author 5:
Organization:
Country:
Co-author 6:
Organization:
Country:

References:

Reference 1: A. Taraiya and I. Ward, "Production and Properties of Biaxially Oriented Polyethylene Tubes," *Journal Applied Polymer Science,* pp. 627-638, 1996.
Reference 2: I. Ward, A. Taraiya and P. Coates, "Solid-State Extrusion and Die-Drawing," in *Solid Phase Processing of Polymers*, Munich, Hanser publishers, 2000, pp. 328-367.
Reference 3: M. Soliman, P. Voets, R. Kleppinger, C. Morath and I. Ward, "Biaxially Oriented Polypropylene Pipes: Implications for Impact and Hydrostatic Pressure Resistance," *Plastics, Rubbers and Composites,* vol. 35, no. 10, pp. 447-454, 2006.
Reference 4:
Reference 5:
Reference 6:
Reference 7:
Reference 8:
Reference 9:
Reference 10:
Reference 11:
Reference 12:

Images:

Images Guidelines: *Please provide maximum one, on a separate file (doc, pdf, tiff, gif, or bmap), and at a reasonable resolution.*

Abstract:

Biaxial drawing of semi-crystalline polymers is typically used in applications including, for example, biaxial oriented PE- and PP-films or thermoformed products. Implementing biaxial drawing for production of biaxially oriented polyolefin pipes provides a route for production of pipe products with properties outperforming those prepared via a standard pipe extrusion process. Besides improvements in Young's modulus and impact behavior, the improvements in hydrostatic pressure and chemical resistance reported recently are of particular interest with regard to final applications of these new products.

Utilizing biaxial drawing in biaxial pipe production poses significant challenges, in particular with regard to controlling drawing conditions during the solid-state deformation process as they affect the final morphology of the product formed under ambient conditions. Ideally, the drawing process causes orientation of polymer chains along both, axial and hoop direction, but in practice equibiaxial orientation is encountered only in cases where processing speed are decreased to levels that are not attractive from a commercial point of view. In fact, several parameters like draw ratios, draw speed and in particular draw temperature provide a strong influence on the semi-crystalline morphology of the final product and hence, its macroscopic properties.

On a macroscopic scale, many of these aspects are related to the three-dimensional orientation distributions of the polymer chains and can be extracted via analysis of the crystalline texture of the materials. The presence of a pronounced axial-type orientation appears to be a disadvantage, in particular when considering dimensional changes of the products under application conditions. Consequently, it is of crucial importance to quantify the extent of conversion towards the favorable biaxial-type orientation. In this contribution, we offer different routes to obtain the conversion ratio by analyzing orientation behavior throughout the material cross section.