

## Accepted Manuscript

Title: Polymer Spherulites: A Critical Review

Author: Buckley Crist Jerold M. Schultz

PII: S0079-6700(15)00128-8

DOI: <http://dx.doi.org/doi:10.1016/j.progpolymsci.2015.11.006>

Reference: JPPS 964



To appear in: *Progress in Polymer Science*

Received date: 16-12-2014

Revised date: 15-10-2015

Accepted date: 23-11-2015

Please cite this article as: Crist B, Schultz JM, Polymer Spherulites: A Critical Review, *Progress in Polymer Science* (2015), <http://dx.doi.org/10.1016/j.progpolymsci.2015.11.006>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

# Polymer Spherulites: A Critical Review

Buckley Crist\*

Department of Materials Science & Engineering  
Northwestern University

Jerold M. Schultz\*

Department of Chemical Engineering  
University of Delaware

## Abstract

Polymeric and non-polymeric materials often crystallize as spherulites when crystallized from viscous melts or solutions at large undercooling. The essential component of a spherulite is fibrillar crystals that grow in predominantly radial directions and branch irregularly. We review the growth, branching and twisting of crystals in the light of theoretical and experimental advances of the last decade, while maintaining an appreciation for historical context.

The crucial role of self-generated fields ahead of the crystal-melt interface is developed. Pressure gradients from volume contraction have been treated, as well as impurity gradients ahead of a growing crystal; fibril width  $W$  is predicted and found to be proportional to  $\delta^{1/2}$ , where the diffusion length  $\delta = D/G$ , the quotient of diffusivity and growth rate, conveys the extent of the field gradient. Ribbon-like spherulite radii grow at a constant rate under diffusion coupled interface control.

Non-crystallographic branching is required to maintain the volume occupied by fibrillar crystals as the spherulite radius increases. Topological giant screw dislocations and induced nucleation at cilia tethered to crystals are observed mechanisms leading to branching normal to the wide dimension of lamellar crystals; but the relative importance of each of these is not yet established. Repetitive tip splitting by kinetic interface instability has been suggested as a branching mechanism in the wide dimension of lamellar crystals.

Larger molecular mass reduces the spherulite growth rate, more so at low undercoolings, for reasons that remain unresolved. Miscible diluents often profoundly reduce  $G$  by lowering both thermodynamic driving force and local transport dynamics that govern the secondary nucleation rate. Spherulite blend morphology is linked to the competition between radial growth rate  $G$  and diffusivity  $D$  of the diluent, expressed as the diffusion length  $\delta$ .

Polymer crystals in which chain helices all have the same sense show banded spherulites, as do crystals in which the chain axes are not perpendicular to the basal surfaces. Recent analyses with optical birefringence and X-ray micro-diffraction support the presence of helicoidally twisted ribbons, although other structural arrangements have sometimes been

Download English Version:

<https://daneshyari.com/en/article/5207961>

Download Persian Version:

<https://daneshyari.com/article/5207961>

[Daneshyari.com](https://daneshyari.com)