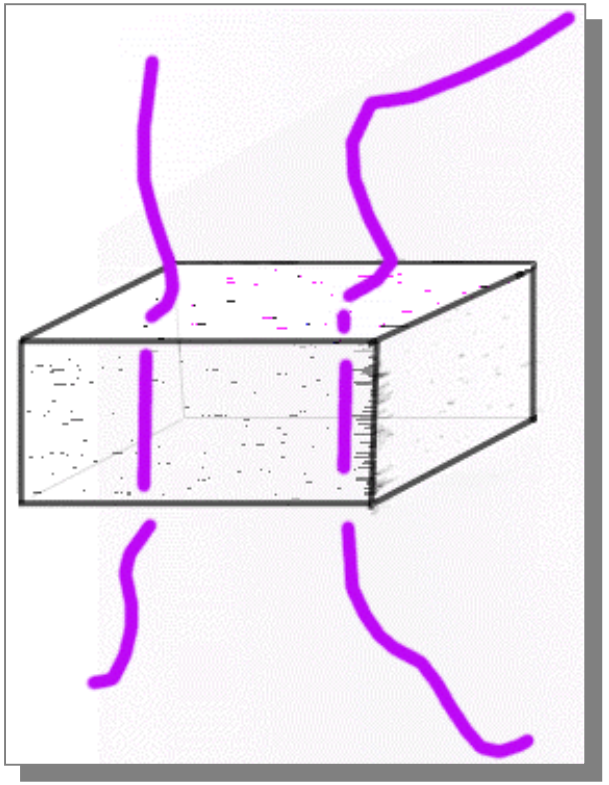
We Have Learned . . .

Polymer crystallization is incomplete.



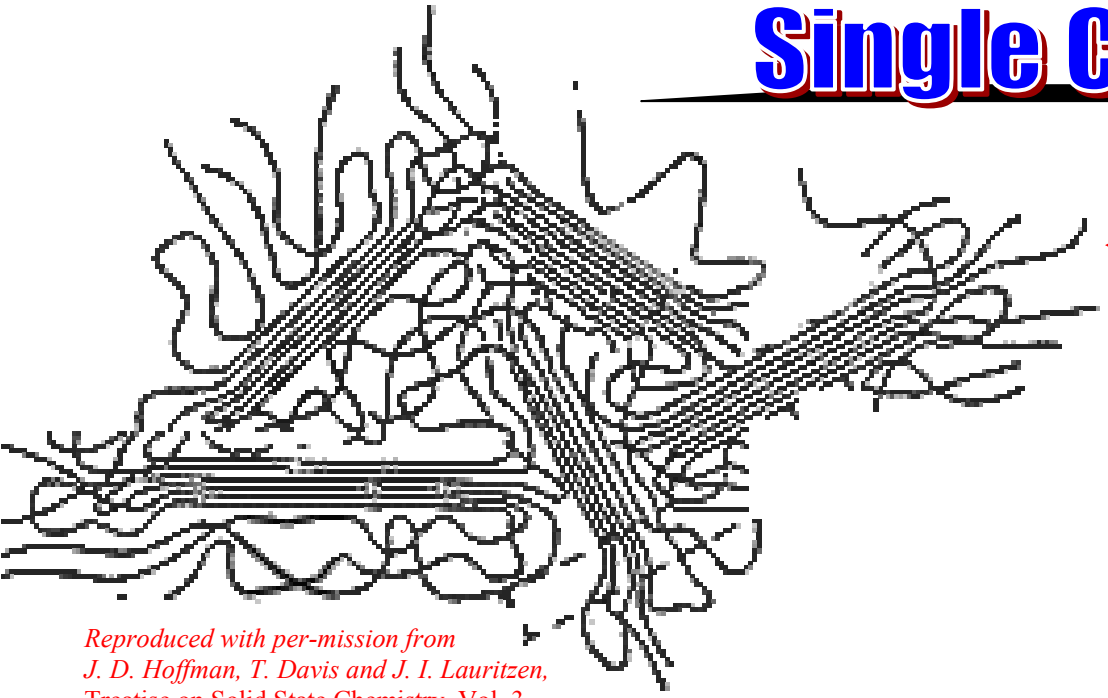
Diffraction experiments

- *Chain confrontation*
- *Mode of packing*

Chain location

- *Is it entirely within the crystalline part ?*
- *Entirely within amorphous bits ?*
- *Pass through both regions ?*

Fringed Micelles to Single Crystal Lamellae



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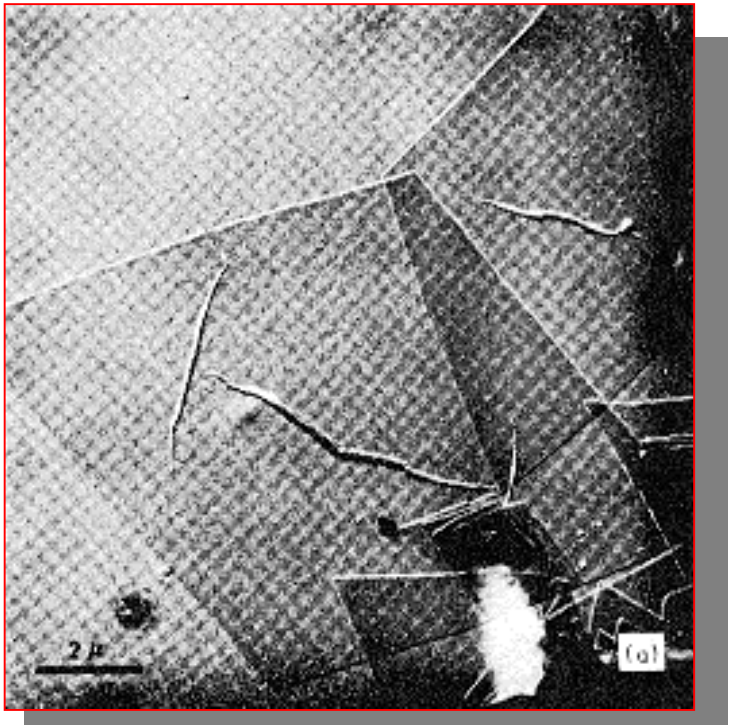
J. D. Hoffman, T. Davis and J. I. Lauritzen,
Treatise on Solid State Chemistry, Vol. 3,
Chapter 7, Plenum Press, New York, 1976.

The 1st Really Useful Model

Electron Micrograph of a Polyethylene Solution Grown Single Crystal



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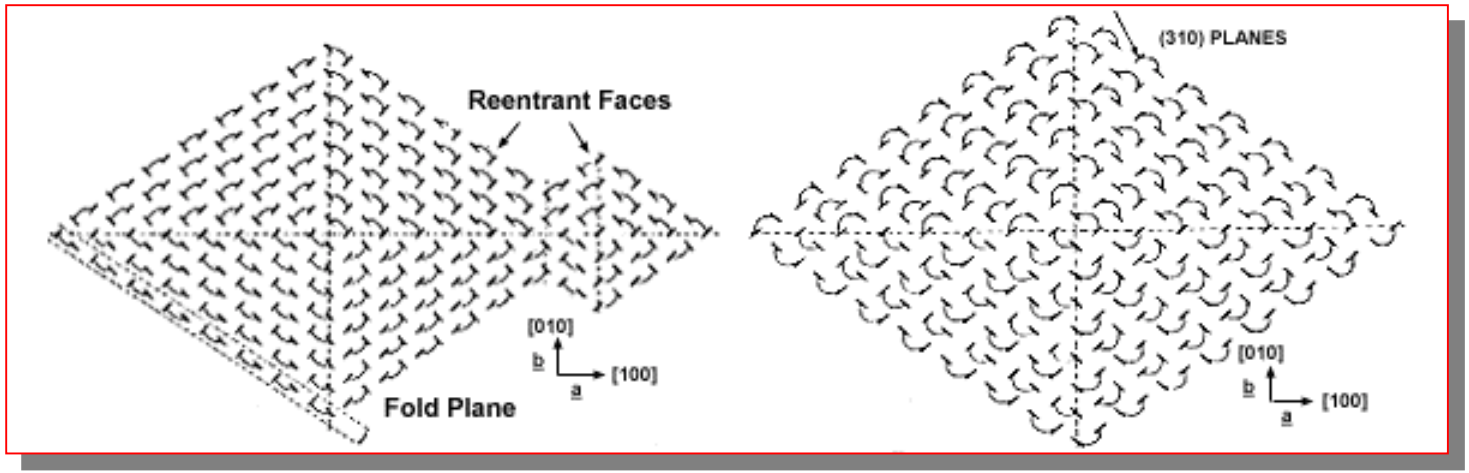
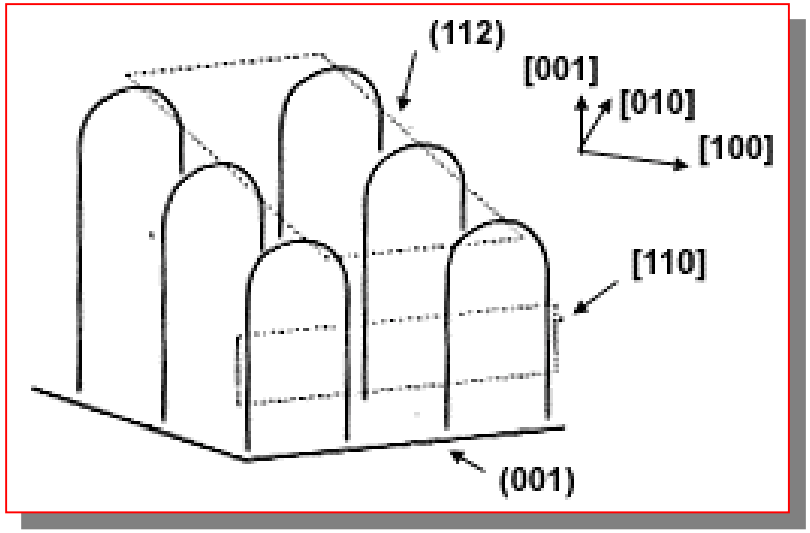
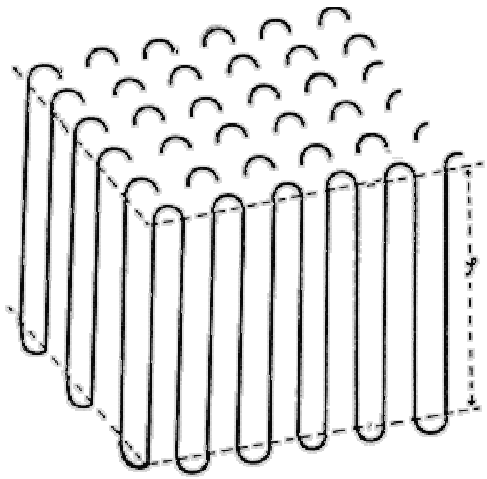
P. H. Geil, *Polymer Single Crystals*,
Robert E. Krieger Publishing
Company, Huntington, New York, 1973.

Regular Chain Folding

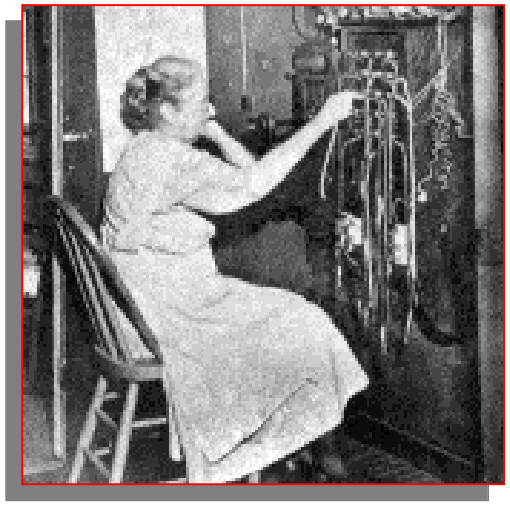




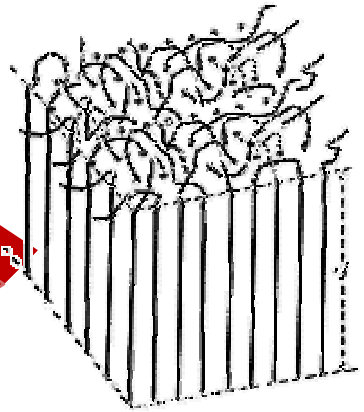
Flory Switchboard Model



Regular Folding Chain
(Adjacent Re-entry)



Irregular Chain Folding
(Random Re-entry)



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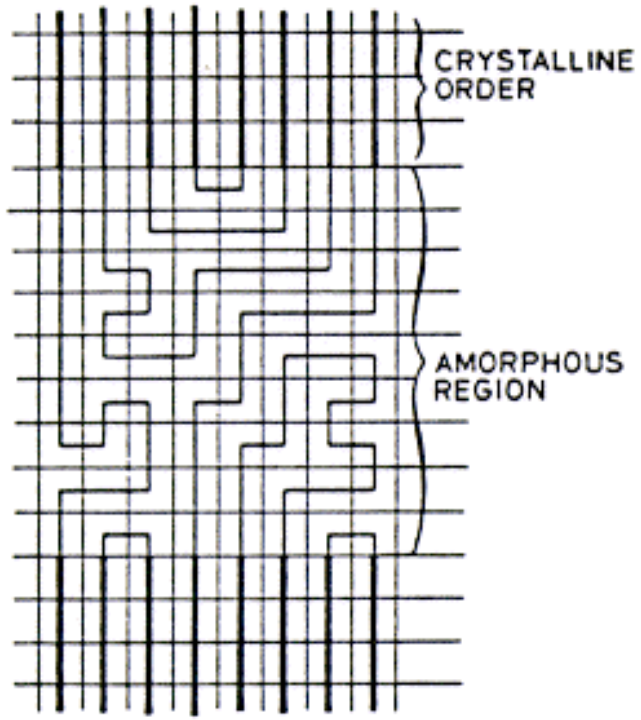
Introduction to Telephone Switching,Addison Wesley,1983

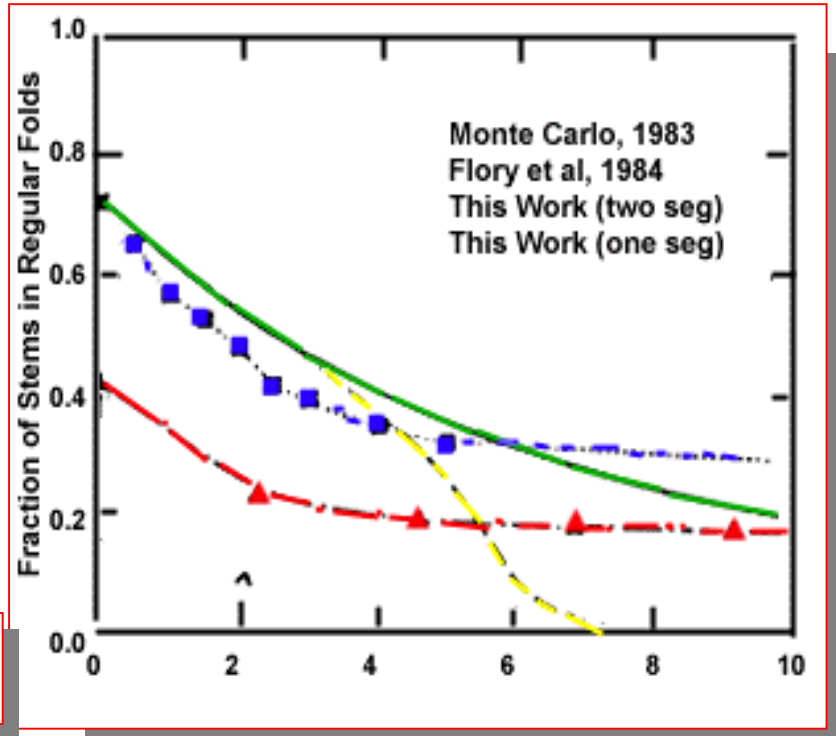
Reproduced with permission from P. J. Flory,
JACS, 34, 2857 (1962

Flory Strikes Back !



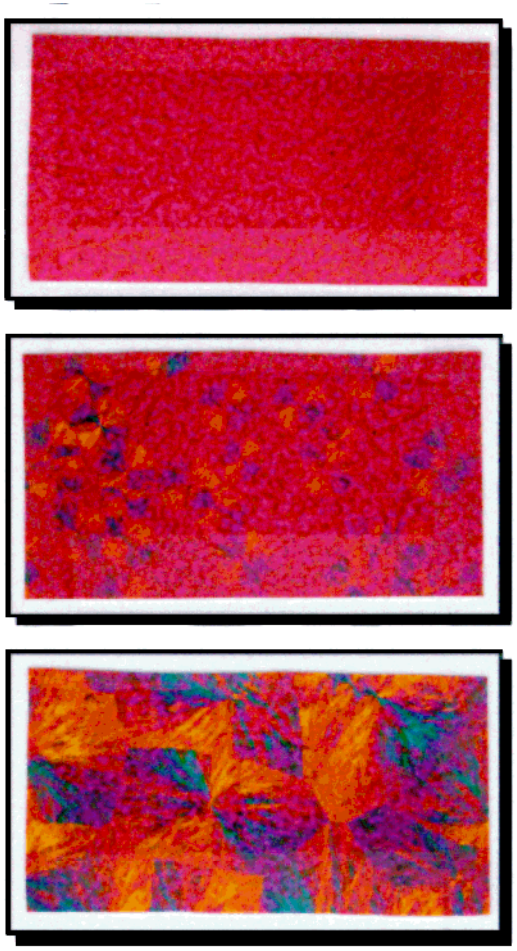
From Dill and Flory

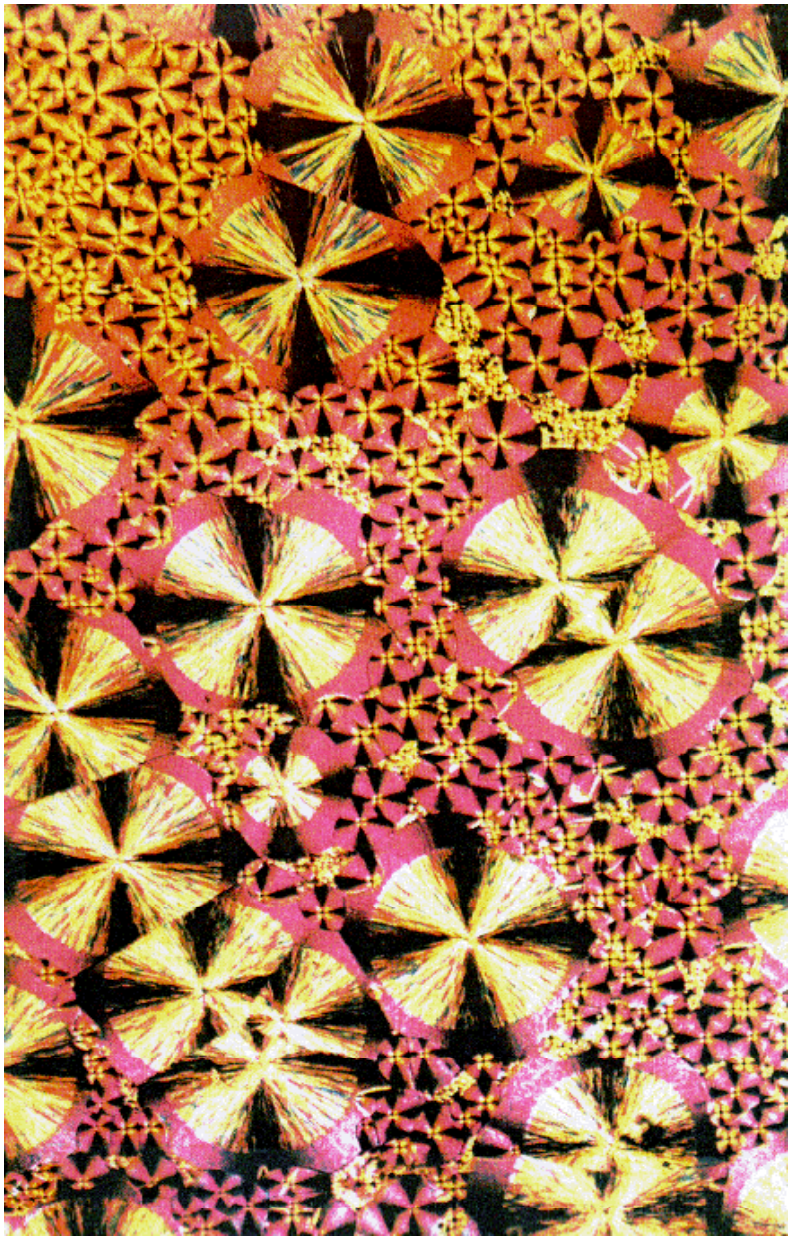
. *Reproduced with permission from K. A. Dill and P. J. Flory,* Proc. Nat. Acad. Sci., *77, 3115 (1980).*



From Kumar and Yoon

SPHERULITES

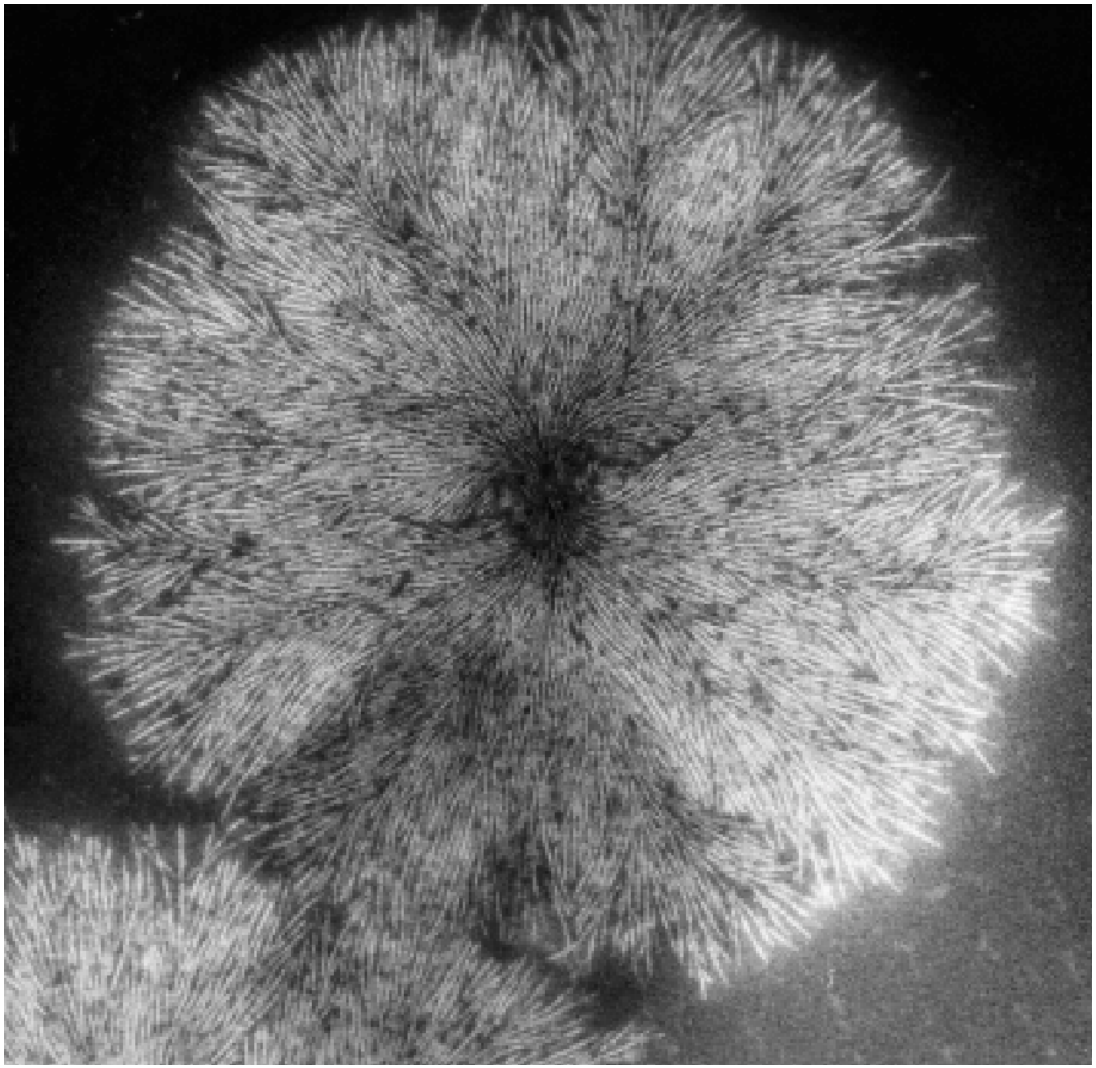




SPHERULITES

start (nucleate/initiate)

grow (spherically)



overlap (impinge)

grow more
to cover all space

Structure of Spherulites

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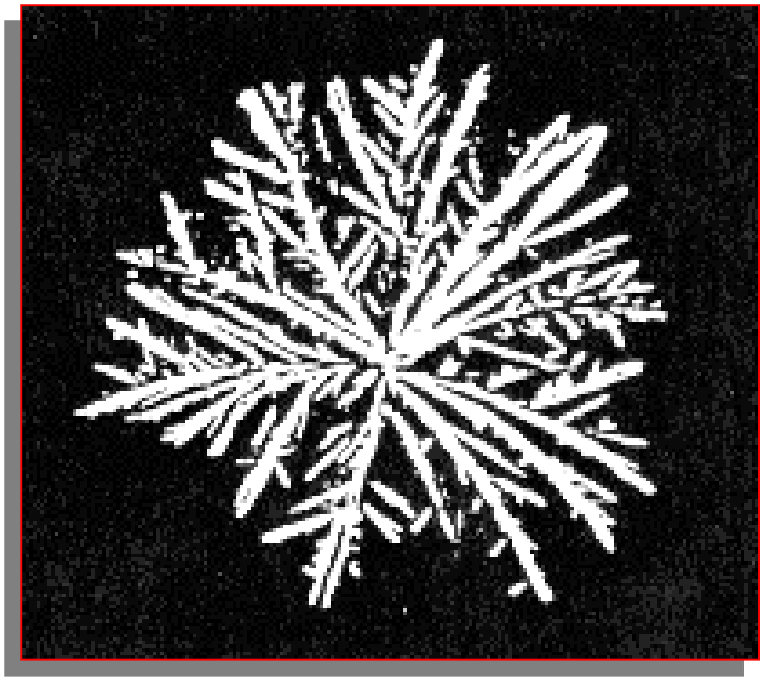
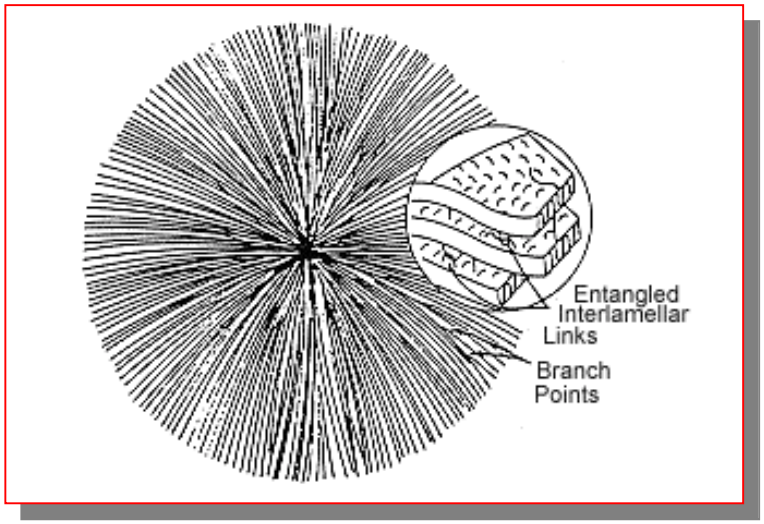


IPP Spherulite Grown from a 10 %IPP, 90% APP Mixture

A Model for the Structure of Spherulites



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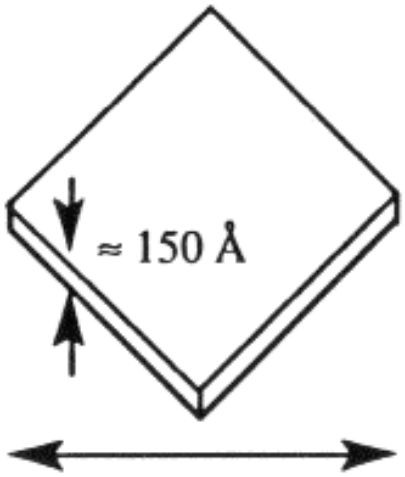
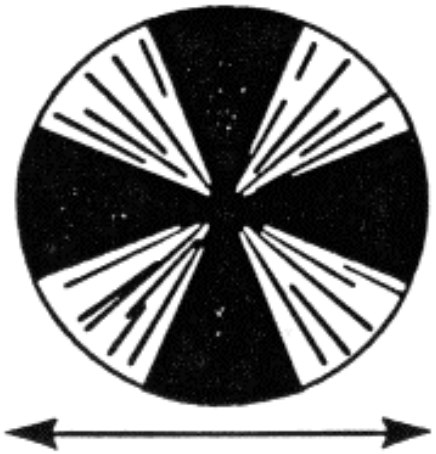
Lamallae & Spherulites

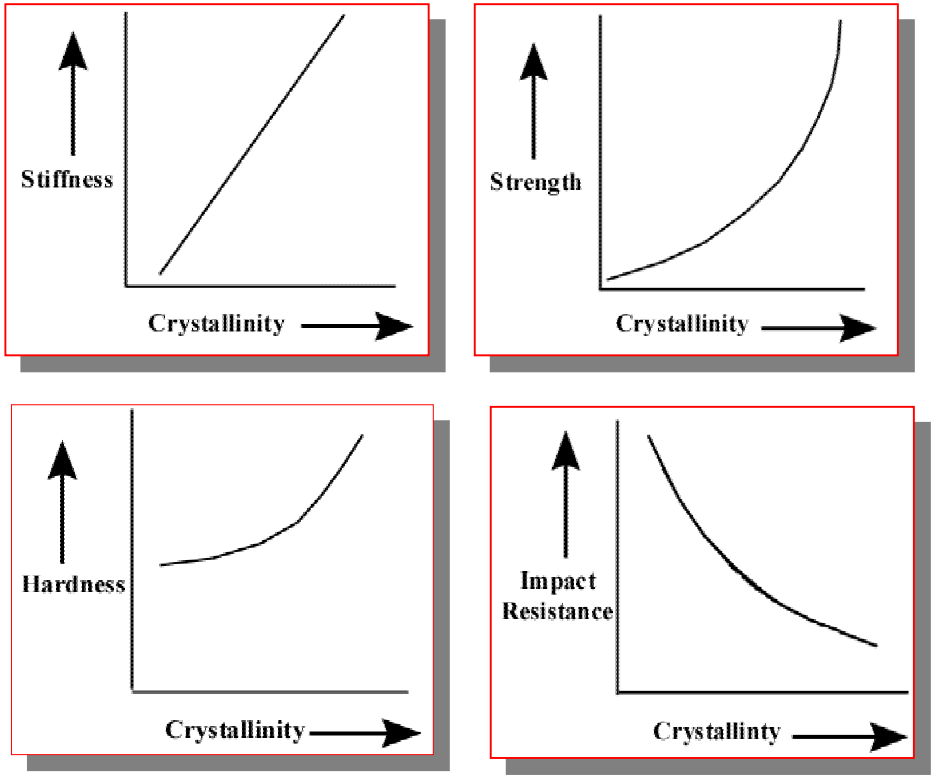
How Big Are They?

Interchain Distance in Polymer Crystals	Solution Grown Single Crystal	Growing Spherulite
		
≈ 5 Å	$\approx 1.5 \times 10^{5}$ Å	$\approx 1 \times 10^{6}$ Å
5×10^{-4} µm	15 µm	100 µm
5×10^{-8} cm	1.5×10^{-3} cm	1×10^{-2} cm

Properties of Polymers

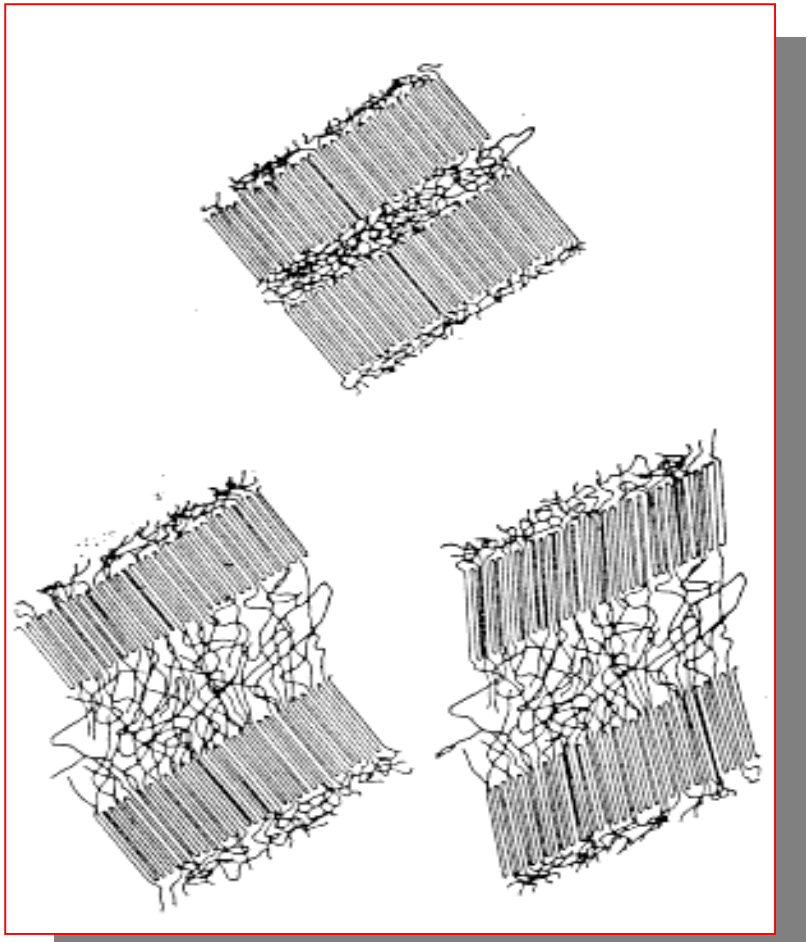
Crystallization: Its Relationship to Properties

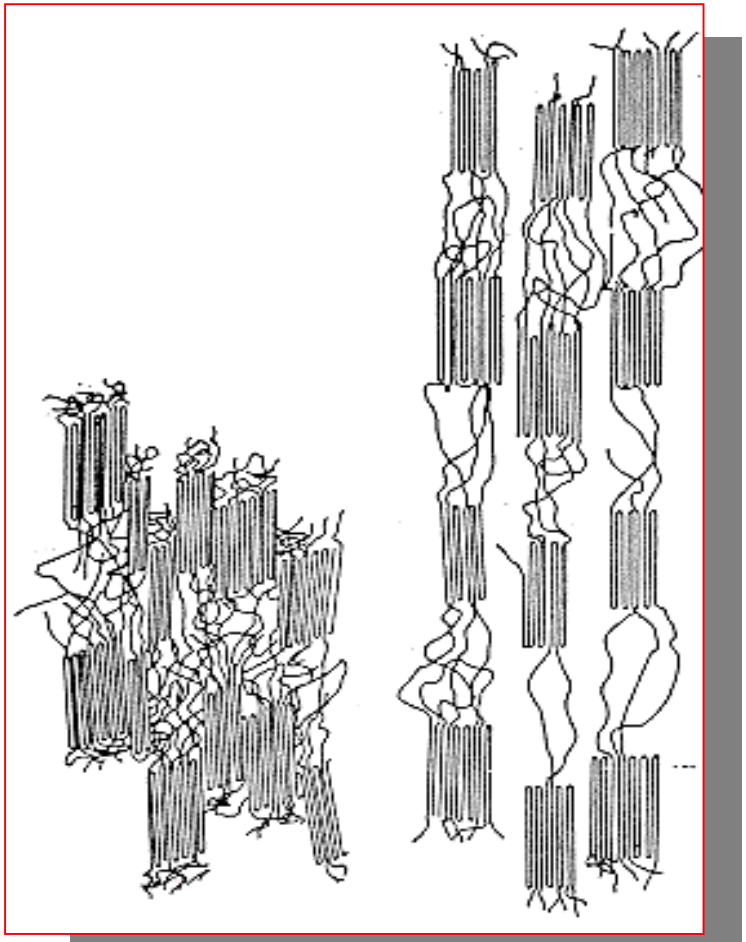
Increasing the Degree of Crystallinity Produces a Stiffer, Harder, Stronger Material. But, the Impact Resistance Decreases



eg: Think about the differences in the physical properties of a polyethylene bucket (relatively high crystallinity) and a garbage bag (relatively low crystallinity).

Fibers





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