Learning Objectives
By the Conclusion of this Lecture, You Should be Able to:

1. **Explain** how differential scanning calorimetry (DSC) measurements can be utilized to measure the melting and crystallization temperatures of semicrystalline polymers.

2. **Recall** general experimental observations regarding polymer crystallization and polymer melting.

Bryan W. Boudouris
Robert and Sally Weist Associate Professor

Davidson School of Chemical Engineering
Purdue University
DSC Determines Thermal Transitions

Differential Scanning Calorimetry (DSC)

Polymer Crystallization is a Complicated Process

Unlike many common small molecule crystals, the experimentally-observed crystallization and melting of semicrystalline polymers will be a combination of kinetic and thermodynamic properties.

This is true because the relatively large macromolecules will have a difficult time organizing on time scales that are rapid in the experimental setting.

Moreover, even given a very long period of time, the likelihood of forming an infinite crystal from a polymeric material is very low considering all of the potential constraints associated with organizing without breaking chain connectivity.

Because of this fact, and the kinetic impacts, the crystallization temperature ($T_c$) of polymers is different from the melting temperature ($T_m$) of polymers.

The lower the crystallization temperature is for a particular polymer or a particular polymer molecular weight, the lower the melting temperature will be. This has to do with the physical dimensions of the crystalline regimes.

The melting and crystallization of the polymers occurs over a range of temperatures. This is different than most small molecule crystals. This range is usually due to the fact that there are a wide range of crystallite sizes within the semicrystalline polymer.

The annealing treatment used on the sample and the scan rate of the heating and cooling cycles (due to kinetic effects) can impact the observed transition temperatures. Thus, care must be taken (and experimental conditions reported) in order to elucidate the true physical phenomena that are occurring.


Next Time: The Impact of Nanoscale Structure on Melting