Physics of Electronic Polymers

Lecture 2.6: Liquid Crystalline Semiconducting Polymers

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

1. **Identify** the four types of liquid crystalline phases that are observed in semiconducting polymer melts.

2. **Describe** what the Maier-Saupé parameter is, and describe how it is used to quantify the rod-rod interaction strength for rod-like polymers in the melt.

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Recall: Molecular Architecture Alters Chain Shape

Coil-Like Polymers Have End-to-End Distances That Go as the Square Root of N

\[
\langle R^2 \rangle^{0.5} = bN^{0.5}
\]

Poly(ethylene oxide)  Polystyrene

Rod-Like Polymers Have End-to-End Distances That Go as N

\[
\langle R^2 \rangle^{0.5} = aN
\]

Polyimide  P3HT
Rod-Like Polymers Also Behave Differently in the Melt

Smectic A

Smectic C

Nematic

Isotropic
Maier-Saupé Parameter Quantifies the Rod-Rod Interactions

Maier-Saupé Mean Field Model

Note that this allows one to approximate the rod-rod attraction strength, and that this parameter (like the interaction parameter) has a term that shows a 1/T dependence.

\[
\mu N \sim C + \frac{D}{T}
\]

\[
(\mu N)_{NI} = 6.811
\]

Because of these interactions, even above the melting point of the materials, there are important thermal transitions (that can be mapped using experimental techniques) that will impact the final properties of the semiconducting polymers.

Mapping Thermal Transitions in Rod-Like Polymers

Next Time: Impact of Molecular Architecture on Liquid Crystalline Transitions