Physics of Electronic Polymers

Lecture 5.1:
Balancing Electronic & Mechanical Properties

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

1. **Explain** why the balance between the mechanical and electronic properties of polymer semiconductors is important in terms of final device implementation.

2. **List** the three types of classes of materials associated with polymer semiconductors and their relative mechanical properties.

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Organic Electronic Devices Have Multiple Design Considerations

Organic Light-emitting Device (OLED) Displays
- Thin and Lightweight
- Flexible
- Transparent

LG
Samsung
Polytron

Organic Photovoltaic (OPV) Devices
- Large Area Production
- Portable Applications
- Conformal Coverage

Infinity PV
Konarka
Heliathek
Design Considerations are Broadened with Biosensors

Hard Electronics on Soft Substrates

‘Smart Wristband’

Flexible sensor array

Wireless flexible PCB

Javey Laboratory

Non-Specific Polymer Electronics

Malliaras Laboratory

The VRH model is in place when the semiconductor is highly disordered both in terms of space and energy. In this system, the states are localized with:

1. **An Energy Distribution** that describes the density of states, which provides the probability for a certain binding energy of a charge in a trap site.

2. **A Spatial Distribution** that accounts for the variable spacings of the trap sites with respect to the ideal repetitive points in a crystal.

The Probability of a Successful Hop is the Same as the Probability Described for Tunneling from a Site of Lower Energy to a Site of Higher Energy

\[
\gamma_{12} = \gamma_0 \exp \left( \frac{-2R}{R_0} \right) \exp \left[ -\left(\frac{E_2 - E_1}{kT}\right) \right] \quad \text{for } E_2 > E_1
\]
We Stressed the Idea of Minimizing the Site-to-Site Distance

P3AT Crystal Schematic

The order provided by crystalline regimes allows for charge to move in a rapid fashion in charge-conducting polymers.

This charge transport can be either along a single chain or between adjacent chains.
What is Ideal for Stretchable Electronic Applications?

**Single Crystals**


**Amorphous**


**Semicrystalline**


Scale Bar = 1 µm

Next Time: An introduction as to how to describe the mechanical properties of polymers.