Physics of Electronic Polymers

Lecture 4.10: Doping in Radical Polymers

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

1. **Define** what is meant by a radical polymer dopant in terms of molecular structure, and compare and contrast its features to that of common conjugated polymer dopants.

2. **Explain** the current benefits and limitations in doping of radical polymers with molecular oxidation-reduction (redox) pairs.

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There is an Optimized Level of Doping in PTMA

Clear Peak in Conductivity

Three Distinct Regimes

1) Combination of PTMPM and PTMA
2) Beginning to Form PTMA and PTMA$^+$
3) Side Reactions Form Insulating Species
Addition of an Oxoammonium Cation Small Molecule

Small Molecule Doping of PTMA with TEMPOntium

Radical and Cation Functionalities are Present in the Thin Films

4-acetamido-2,2,6,6-tetramethyl-1-oxopiperidinium tetrafluoroborate (TEMPOnium)
Small Molecule Doping Allows for Conductivity Tuning

Addition of TEMPOonium Results in 5x Increase in Conductivity

Increasing Levels of TEMPOonium Leads to Poor Film Quality

Baradwaj, A. G.; Wong, S. H.; Laster, J. S.; Wingate, A. J.; Hay, M. E.; Boudouris, B. W.

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Review of the Key Concepts of Unit 4

During the previous lectures, we have:

1. Discussed how alignment of semiconducting polymers impacts their ability to transport charge across macroscopic distances in OFETs.

2. Explained how liquid crystalline polymers can be used to generate OFET thin films with large crystalline domains.

3. Described how block polymers can be used to control the nanoscale structure in multicomponent organic electronic devices like organic photovoltaic (OPV) devices.

4. Motivated how crystallization and nanoscale phase separation can be in competition and how these issues can be overcome.

5. Introduced the new organic electronic design paradigm of radical polymers, and demonstrated how molecular control and doping can be used to manipulate charge transport in these materials.

In the Next Unit: We will discuss the state-of-the-art with organic electronic devices and how these advances are tied to polymer physics.