



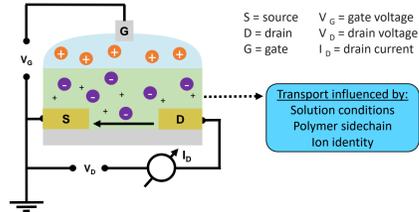
High-throughput Investigation of Block Copolymer and Conjugated Polymer OMIEC Blends

Karen Li, Lilo Pozzo

University of Washington, Department of Chemical Engineering, Email: kli625@uw.edu

Introduction

Organic Mixed Ionic Electronic Conductors (OMIECs)



Organic materials that exhibit ionic and electronic conducting properties.

- Binders in batteries and supercapacitors
- Transducer in biosensors
- Artificial synapses in neuromorphic computing

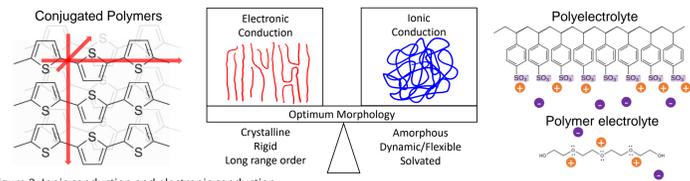


Figure 1. Organic electrochemical transistor (OECT)

Figure 2. Ionic conduction and electronic conduction

- OMIECs are typically composed of ionic conducting polymer moieties and charge conducting conjugated polymers
- Need to improve fundamental understanding of the connection between OMIEC morphology and mixed conduction

BCP-CP OMIEC

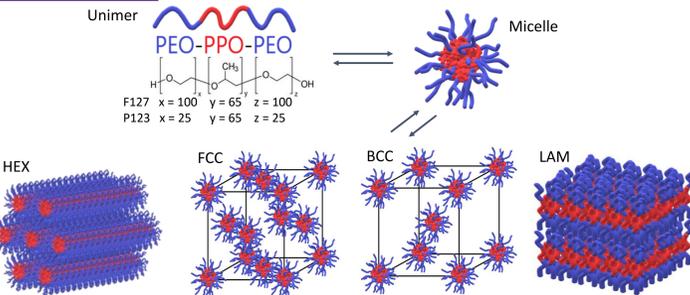
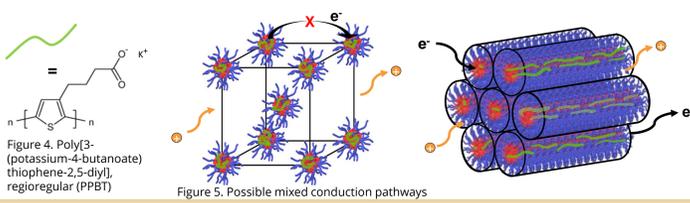


Figure 3. Structure of Pluronic Block Copolymer



Sample Preparation

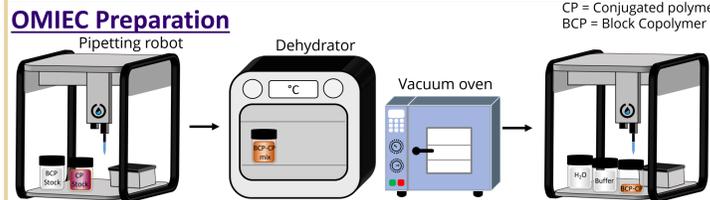


Figure 6. High-throughput OMIEC sample preparation process

High-throughput Small Angle Scattering



Figure 7. High-throughput small angle x-ray scattering (HT-SAXS)

<https://github.com/pozzo-research-group/Automation-Hardware>

OMIEC Structure

Peak Indexing with Pluronic F127

Structure	Ratio q/q^*
FCC	$1, \sqrt{4/3}, \sqrt{8/3}, \sqrt{11/3}, \sqrt{12/3}, \sqrt{16/3}, \dots$
BCC	$1, \sqrt{2}, \sqrt{3}, \sqrt{4}, \sqrt{5}, \sqrt{6}, \dots$
HCP	$1, 1.06, 1.13, 1.46, 1.73, 2.56, \dots$
HEX	$1, \sqrt{3}, \sqrt{4}, \sqrt{7}, \sqrt{9}, \sqrt{12}, \dots$

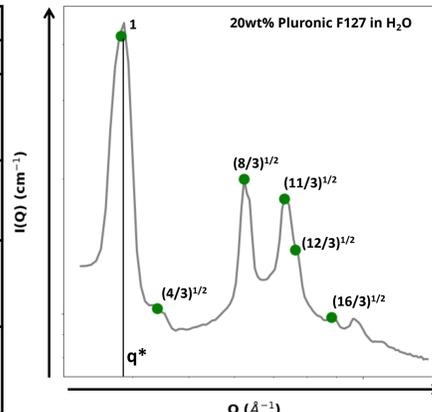


Figure 8. FCC structure of 20wt% Pluronic F127 in H₂O.

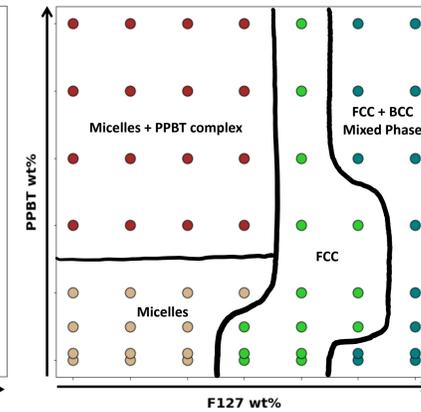


Figure 9. Phase diagram of F127-PPBT OMIECs

P123-PPBT OMIECs

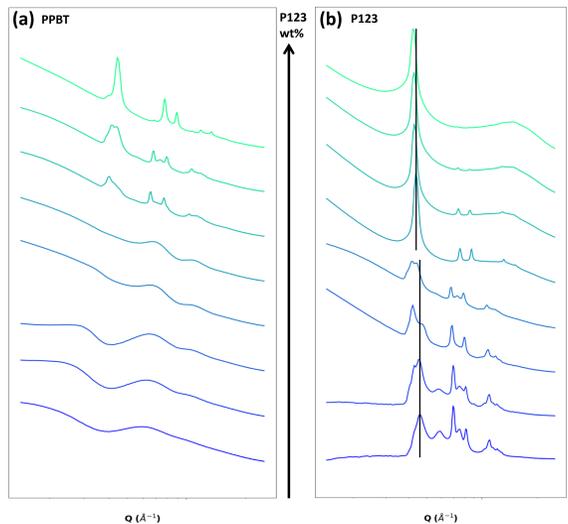


Figure 10. SAXS spectra of P123-PPBT OMIECs at varying (a) P123 concentration and (b) PPBT concentration

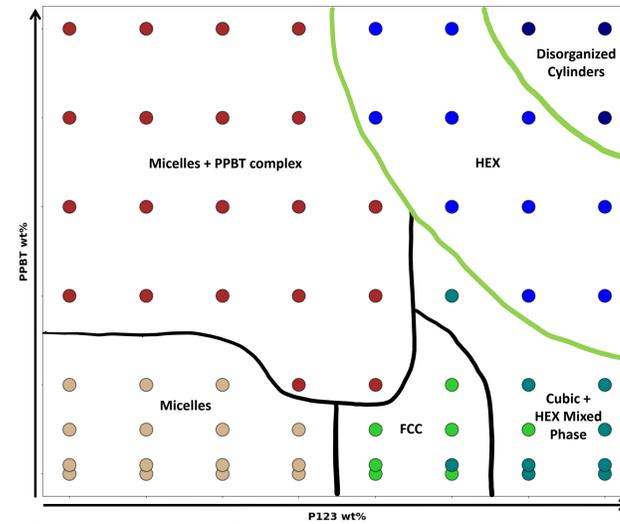


Figure 11. Phase diagram of P123-PPBT OMIECs

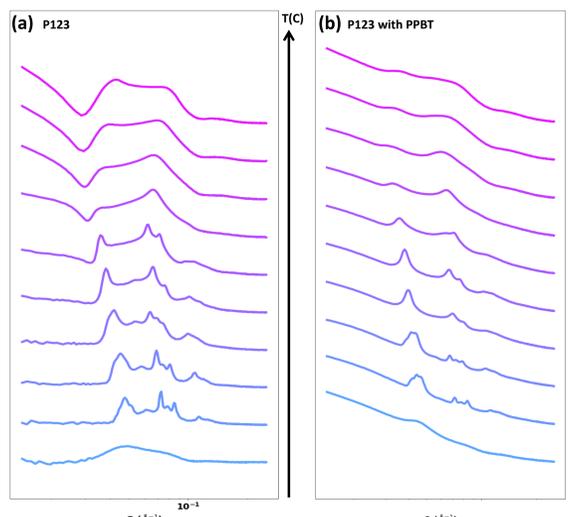


Figure 12. SAXS spectra of P123-PPBT OMIECs at varying temperatures with (a) no PPBT and (b) 1wt% PPBT

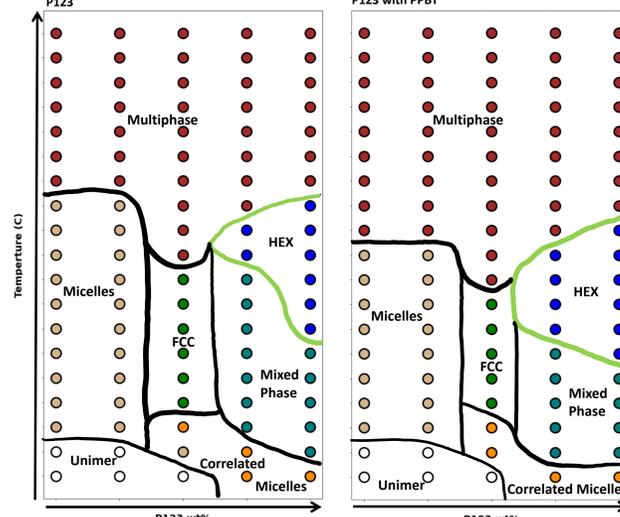


Figure 13. Phase diagram of P123-PPBT OMIECs at different temperatures and polymer concentration

Cross-linked OMIEC Structure

Crosslinking with F127-BUM

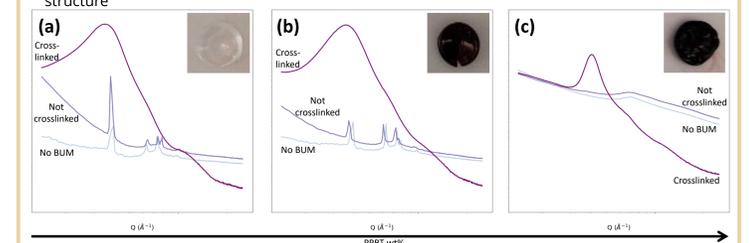
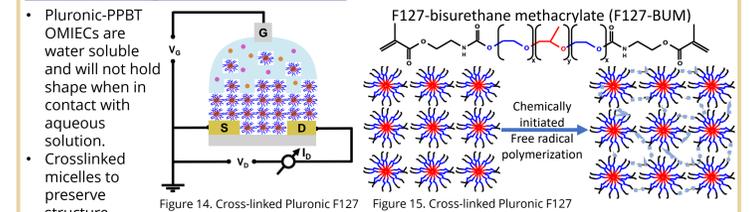


Figure 16. Structure of chemically initiated 20 wt% crosslinked F127-BUM (a) without and (b, c) with PPBT

Conclusions

- Organized mixed polymer systems can be formed with Pluronic and PPBT
- Addition of PPBT influences OMIEC structure
 - Pluronic-become more disorganized at high concentrations of PPBT
 - In P123-PPBT OMIECs, the addition of PPBT shifts structure toward continuous phases (hexagonal cylinders)
 - This shift toward more continuous phases also occurs with different temperature
- Micelle size increases with increasing concentration of PPBT
 - Swelling of micelles may indicate PPBT is located in the micelle core
- Structure is lost when Pluronic-PPBT OMIECs are crosslinked
 - Conflict between the micelles self-assembling and the BUM crosslinking

Future Work

- Crosslink Pluronic-PPBT OMIECs through photoinitiated free radical polymerization
 - Allows micelles to organize themselves before crosslinking
- Identify the segregation state of the CP components through small angle neutron scattering
- Shear orientation of templated OMIEC domains to create single-crystalline and macroscopically aligned domains to improve ionic and electronic conductivity
- Explore different polymer OMIEC systems
 - E.g. Block copolymer polystyrene-b-polyethylene oxide and conjugated polymer poly-3-hexylthiophene
- Test transconductance (ionic conductivity and electronic conductivity) of BCP-CP OMIECs with OECTs
 - Crosslinked Pluronic-PPBT OMIECs
 - Other polymer OMIEC systems

Acknowledgements

Primary support for this work was provided by the Department of Energy Office of Basic Energy Sciences under award number DE-SC0019911. This material is based in part upon work supported by the State of Washington through the University of Washington Clean Energy Institute. Thank you to Dr. Lilo Pozzo and the Pozzo group for their support and guidance. Thank you to Soenke Seifert at APS 12-ID-C for assisting in SAXS experiments.

