Synthesis of polythiophene based conjugated polyelectrolytes

Markus Mühlinghaus[a], Mario Kraft[a], Judith E. Houston[b], Ian Mooney[b], Ann E. Terry[c], Michael Forster[a], Rachel C. Evans[b] and Ullrich Scherf[a]

a Macromolecular Chemistry Group and Institute for Polymertechnology, Bergische Universität Wuppertal, D-42097 Germany

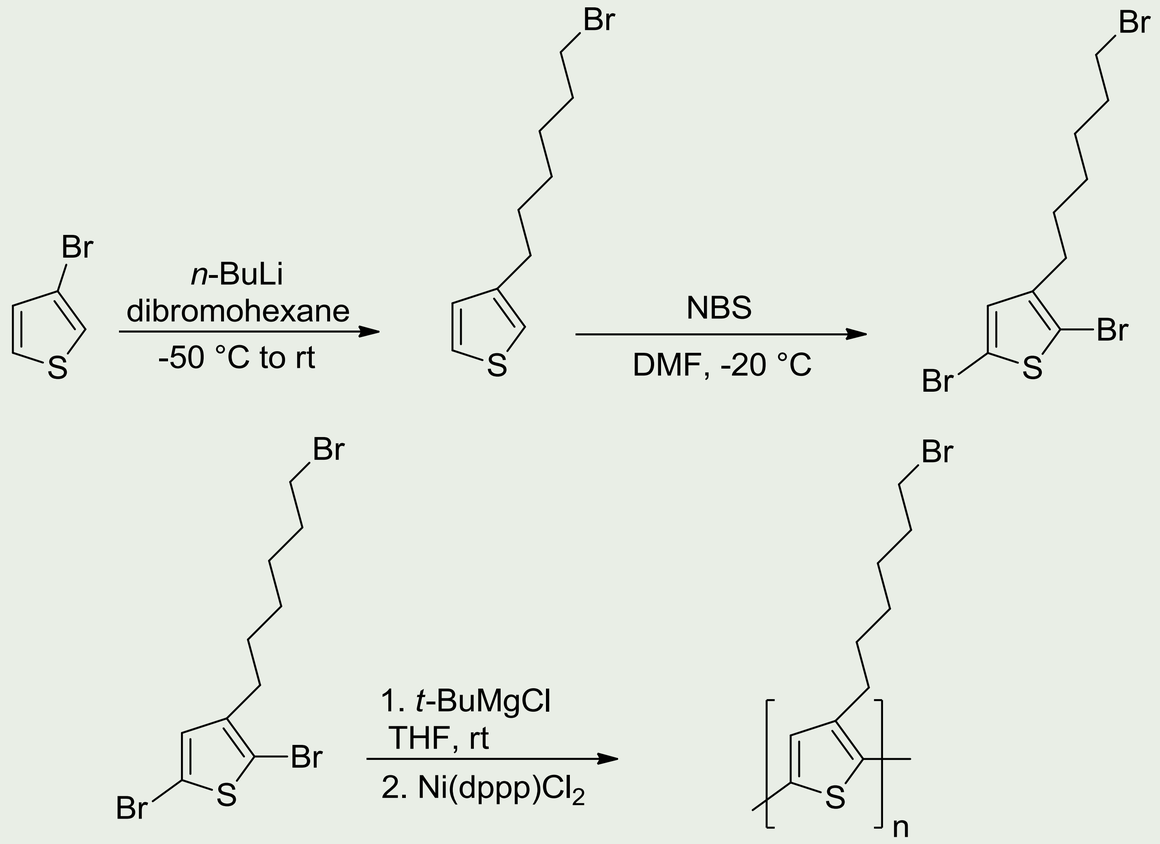
b School of Chemistry, University of Dublin, Trinity College, College Green, Dublin 2, Ireland

c ISIS, STFC, Rutherford Appleton Laboratory, Didcot, Oxon OX11 0QX, U.K

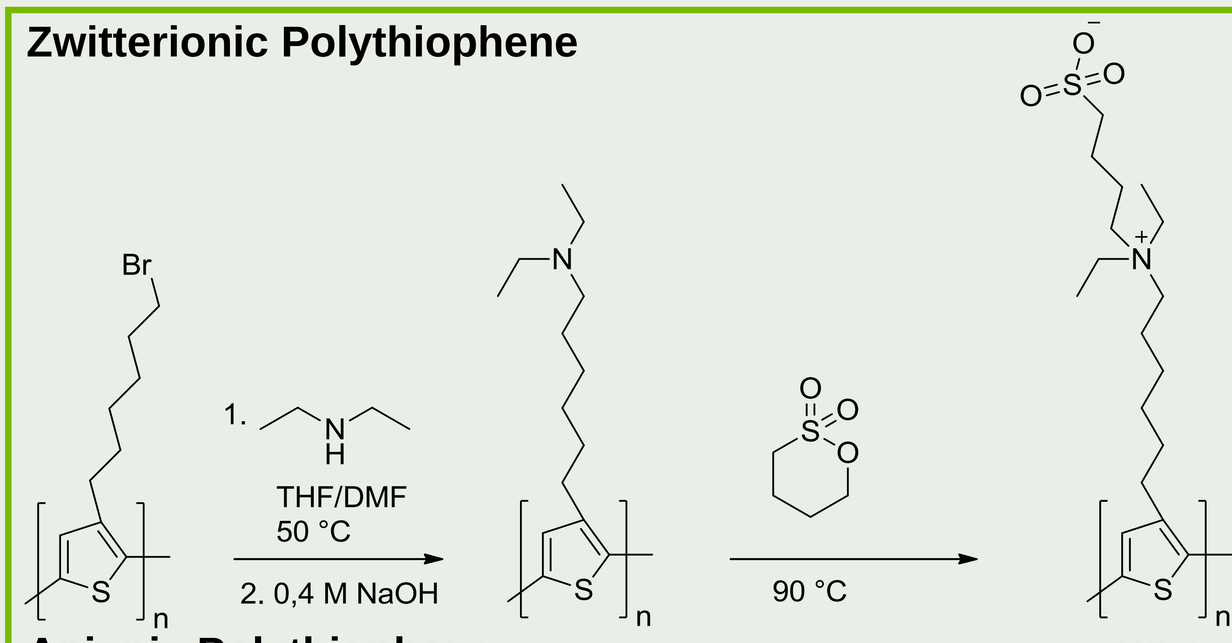
Introduction

Conjugated polyelectrolytes (CPEs) are aromatic polymers with a π-conjugated backbone and main- or side-chain ionic groups. Water- and alcohol-soluble CPEs are discussed as components of organic electronic devices e.g. for the fabrcation of chargetransport interlayers. Due to their solubility in polar solvents multilayer devices can be solution-processed by spin coating or doctor blading. The incorporation of CPE layers in optoelectronic devices (e.g. organic or Perovskite-type solar cells) leads to an enhancement of the device performance.[1,2]

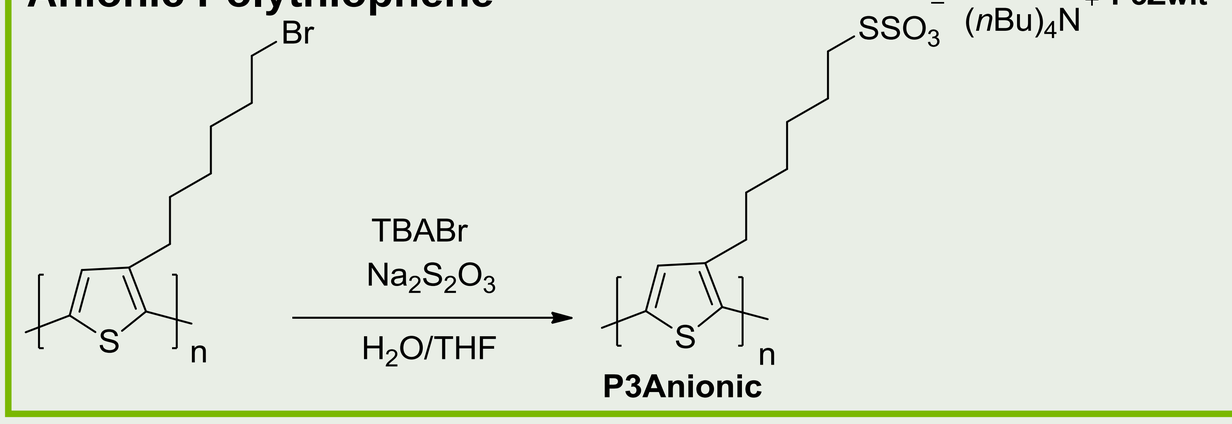
Precursor Polymer Synthesis



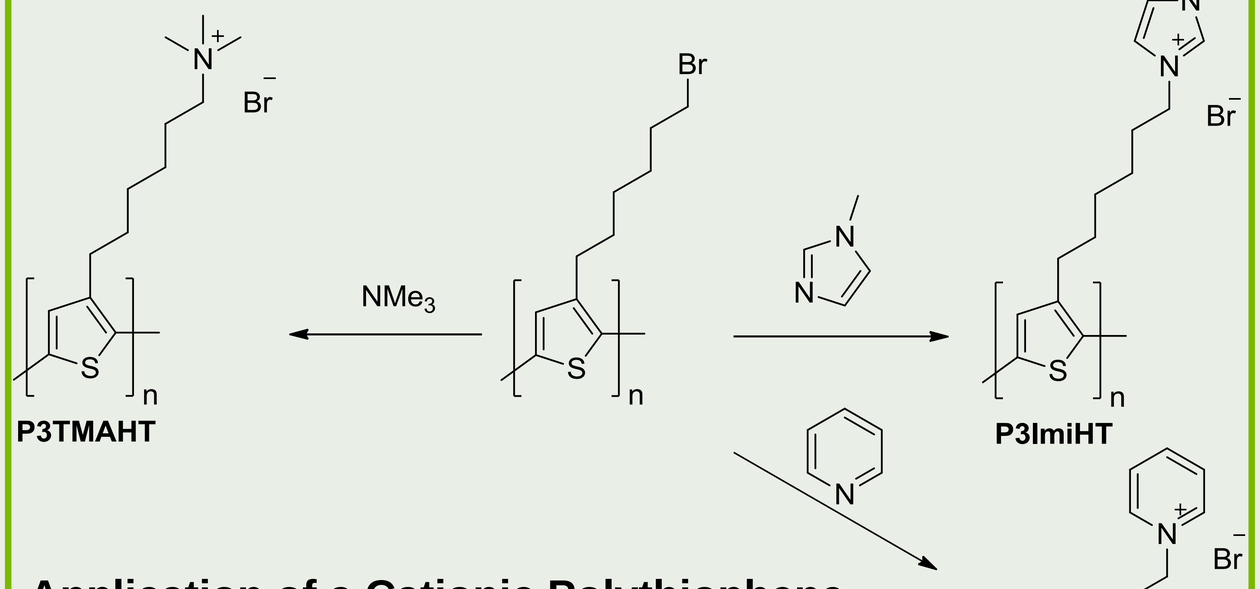
Zwitterionic Polythiophene



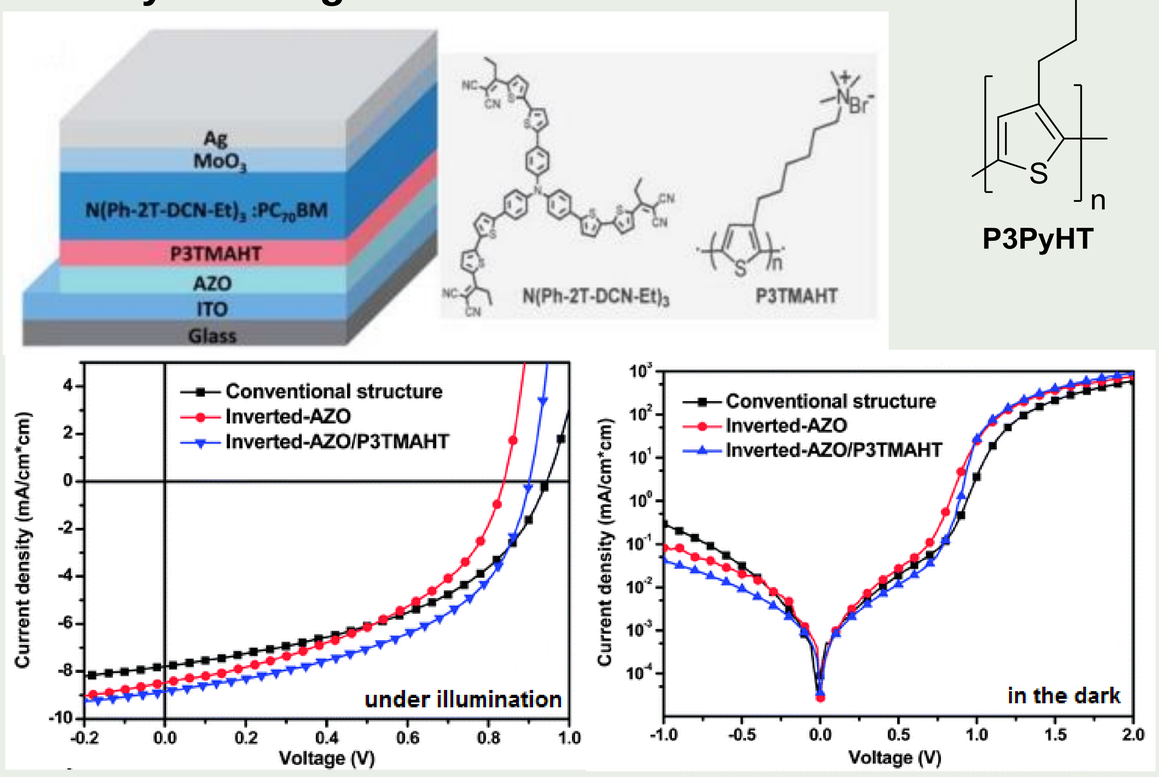
Anionic Polythiophene



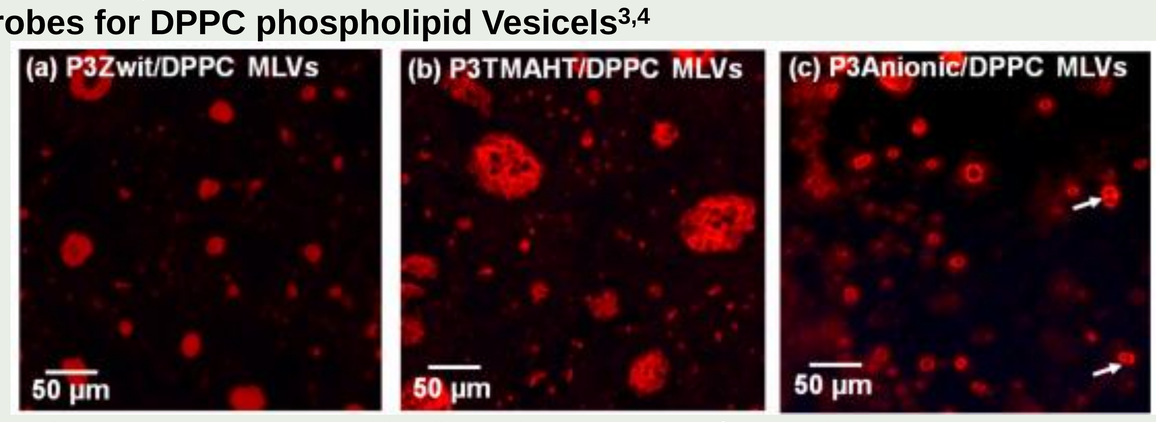
Cationic Polythiophenes



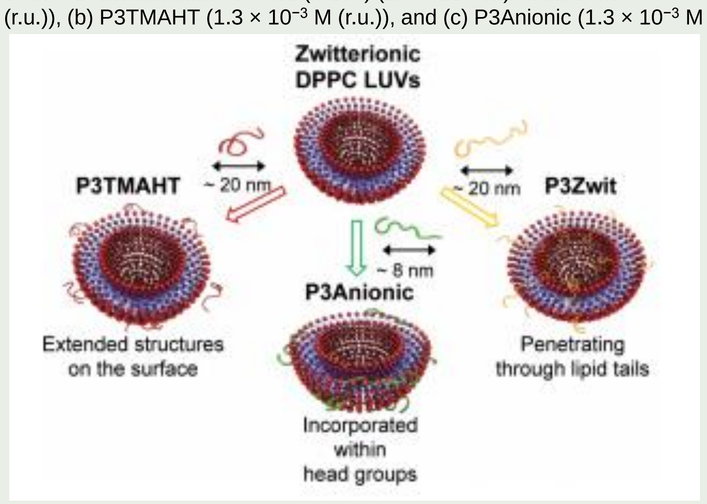
Application of a Cationic Polythiophene interlayer in Organic Solar Cells[2]



Use of Polythiopene-based CPEs as fluorescence Probes for DPPC phospholipid Vesicels[3,4]



Epifluorescence images of DPPC multilamellar vesicles (MLVs) (2.6×10^{-3} M) treated with (a) P3Zwit (1.3×10^{-3} M (r.u.)), (b) P3TMAHT (1.3×10^{-3} M (r.u.)), and (c) P3Anionic (1.3×10^{-3} M (r.u.)), λ_{ex} = 435 nm



Schematic representation of the proposed CPE/DPPC vesicle interactions

Conclusion

We have successfully synthesized different, polythiophene-based CPEs from only one precursor polymer. Polymer-analogous modification of the bromoalkyl-substituted nonionic precursor allows for the generation of anionic, cationic or zwitterionic polythiophenes. All polyelectrolytes show good solubility in polar solvents as methanol (anionic, cationic CPEs), dimethyl sulfoxide (anionic, cationic, zwitterionic CPEs) and water (zwitterionic CPE). Increased power conversion efficiencies could be observed for organic solar cells with cationic polythiophene-based electrode interlayers.

Ref.: (1) H. Zhang, H. Azimi, Y. Hou, T. Ameri, T. Przybilla, E. Spiecker, M. Kraft, U. Scherf, C. J. Brabec, *Chem. Mater.*, **2014**, *26* (18), 5190–5193
(2) J. Min, H. Zhang, T. Stubhan, Y. N. Luponosov, M. Kraft, S. A. Ponomarenko, T. Ameri, U. Scherf, C. J. Brabec, *J. Mater. Chem. A*, **2013**, 1, 11306-11311
(3) J. E. Houston, M. Kraft, I. Mooney, A. E. Terry, U. Scherf and R. C. Evans, *Langmuir*, **2016**, 32, 8141–8153
(4) J. E. Houston, M. Kraft, U. Scherf and R. C. Evans, *Phys. Chem. Chem. Phys*., **2016**, 18, 12423-12427