SEMI-CONDUCTING POLYMERS: AN OVERVIEW OF EFFICIENT SYNTHESIS ROUTES

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ABSTRACT

Since the seminal work on the conductivity of polyacetylene by Heeger, MacDiarmid, and Shirakawa was published in the 1970s, the field of organic electronics has grown exponentially. We have now reached a stage where the quantum efficiencies of OLEDs outperform those of inorganic LEDs, the highest charge mobilities obtained for polymers reach 8.5 cm2 /(V s), and OPVs now have a power conversion efficiency (PCE) of 10.6% (tandem cells). The advances made in organic electronics have been driven by the syntheses of π-conjugated molecules with increasingly complex structures. For example, one polymer, Poly[1-(6-{4,8-bis[(2-ethylhexyl)oxy]-6-methylbenzo[1,2-*b*:4,5-*b*′]dithiophen-2-yl}-3-fluoro-4-methylthieno[3,4-*b*]thiophen-2-yl)-1-octanone] (PBDTTT-CF), provides a PCE of 6.8% (National Renewable Energy Laboratory (NREL) certified value) and has an estimated cost of over $400/g, requiring 10 steps to synthesize starting from basic commercial materials. The cost is approximately 25 times greater than that of poly(3-hexylthiophene-2,5-diyl) (P3HT) synthesis. For organic electronic devices, especially OPVs, to become economically viable, it is important that simple and efficient synthetic strategies are developed to mitigate both the financial and environmental costs associated with the syntheses of organic electronic materials. For this to be achieved, the following challenges should be addressed: (1) develop living polymerization techniques such that semiconducting polymers can be synthesized in a reproducible manner with limited defects, (2) develop sequence specific polymerizations that will allow chemists to synthesize semiconducting copolymers in a single step, and (3) develop cross-coupling techniques that eliminate or reduce the use of organometallic reagents. This talk will focus on the living polymerization of semiconducting polymers and direct arylation methods to synthesize polymers.

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References:

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