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Rozprawa doktorska

Kopolimery skoniugowane – synteza chemiczna i elektrochemiczna wybranych klas kopolimerów oraz rozpoznanie ich właściwości spektroelektrochemicznych

Conjugated copolymers – chemical and electrochemical synthesis of selected classes of copolymers and the investigation of their spectroelectrochemical properties

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Abstract

The primary goal of this thesis was to design and develop a synthetic pathway for synthesising a selected group of conjugated copolymers. The next goal was to evaluate the viability of using this pathway to obtain well-defined copolymers containing the desired chemical structure and chain topology. The final goal was to investigate the fundamental properties of the synthesised copolymers and ascertain their potential applications.

The research began with investigating the state of the art regarding chemical and electrochemical methods of synthesising conjugated copolymers and graft copolymers. This resulted in collating literature reviews of existing scientific and technical literature. Based on these reviews, an initial methodology for synthesising the desired copolymers was established.

The next step was to implement the initially chosen methodology by evaluating the viability of using electrochemical polymerisation to produce well-defined copolymers, using selected conjugated co-monomers. Despite the use of structurally similar co-monomers, i.e. a series composed of indole, carbazole and fluorene, electrochemical copolymerisation of this series with 3-hexylthiophene resulted in sharply differing products, meaningly a homopolymer blend and homopolymers substituted with the co-monomer. Due to this variability, the use of electrochemical methods for synthetic purposes was discontinued.

In the next stage of research, focus was given to chemical synthesis methods. Poly(methylhydrosiloxane) was used as the "template" main chain, onto which polymer or low-molecular side-chains were grafted, using the hydrosilylation reaction. The use of this synthetic pathway allowed well-defined copolymers containing side chains exhibiting p-type (poly(3-hexylthiophene)) and n-type (perylene diimide) conductivity, were readily obtained.

The chemical structure and chain topology of the produced copolymers were confirmed spectroscopically. Following this confirmation, the produced compounds were investigated in terms of their fundamental electrical (conductometry), electrochemical (cyclic voltammetry) and spectroscopic (UV-Vis-NIR spectroelectrochemistry) and were investigated as active materials for selected applications in organic optoelectronics. The results obtained for the initial prtototype devices were highly promising, require optimisation to truly highlight the potential of the produced compounds.