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論文審査の要旨（2000 字程度）

This dissertation titled "Electric Field-Driven Electrosynthesis of Conducting Polymers and Modification of Electrode Surfaces Based on Bipolar Electrochemistry" focuses on preparation of functional one-dimensional (1D) conducting polymers (CPs) with and without templates and personalized modification of electrode surfaces using various organic compounds in a facile way.

Chapter 1 "General Introduction" introduces the fundamentals of bipolar electrochemistry including principles, common electrolytic setups and advantages. Additionally, interesting applications on bipolar electrochemistry from materials science to electroanalysis and motion generation are described.

Chapter 2 "Template-free Vertical Growth of Poly(3,4-ethylenedioxythiophene) Fiber Arrays by Alternating Current-Bipolar Electrolysis" demonstrates the successful growth of perpendicular CP fiber arrays using a cylindrical bipolar electrochemical apparatus, due to the electrophoresis effect of charged oligomers. Plausible growth mechanism that several micrometer-sized islands initially form during an induction period and trigger the subsequent growth is proposed. Besides, the author carried out thorough investigations on influence factors of the PEDOT fibers growth, including electrolytic setups, electrolytic parameters, electrodes substrates and so on. The work developed a facile method to fabricate CP fiber arrays, which could satisfy various practical demands.

Chapter 3 "Fabrication of Polymer Nanowires by Templated Bipolar Electropolymerization Assisted by Electrophoretic Effect" presents an approach to fabricate robust CP nanowires. Electrodeposition of electroactive monomers with the help of the template is a common method to prepare CP-based nanomaterials. However, the nanopores of the template have a high aspect ratio, thus highly limited the diffusion of monomers into the narrow space; therefore, the electropolymerized CPs tend to perform a hollow tubular structure with a low mechanical strength. Here, electrodeposition of monomers was carried out under bipolar electrochemical conditions. Actuated by an external electric field, the migration of charged monomers into the template was effectively improved due to the electrophoresis effect, resulting in densely packed CP nanowires. Positively charged ruthenium-containing monomer was used for reductive electropolymerization, while negatively charged 3-thiophenetrifluoraborate monomer was employed for oxidative polymerization. These obtained polymer nanowires possessed a good mechanical property to keep 1D perpendicular structures. This work proved the inherently high synergy of electrolysis and electrophoresis in a bipolar electrochemical system.

Chapter 4 "Fabrication of Gradient and Patterned Organic Thin Films by Means of Bipolar Electrolytic Micelle Disruption Method Using Redox-active Surfactants" establishes a bipolar electrolytic micelle disruption (BEMD) method to prepare gradient and patterned films. For BEMD approach, an electrolytic micelle disruption process is well integrated with bipolar electrolytic technology. The micelles composed of electroactive surfactants can carry various organic compounds including a polymerizable monomer, an organic dye and luminescent aggregation-induced emission molecules. When these surfactants were oxidized, organic compounds were released from micelles and deposited on the electrode surface. A U-shaped bipolar electrolytic setup generated a sigmoidal potential distribution on the BPE, while a cylindrical bipolar electrolytic setup provided a site-selective potential feature on the BPE. Therefore, the disruption of micelles could selectively procced on the BPE surface, following the potential distribution. Finally, a variety of gradient and patterned organic thin films were formed on the BPE surface. Such a general BEMD approach takes full advantage of bipolar electrochemistry, opening a long-term perspective for electrode surface modifications.

Chapter 5 "General Conclusion" summarizes the results of this study that the electrosynthesis of 1D CPs and the selective modification of electrode surfaces were achieved by bipolar electrochemistry. These achievements offer general approaches on the preparation of materials and greatly extend the application scopes of bipolar electrochemistry. Therefore, it is recognized that this dissertation is of sufficient value as a doctoral thesis.