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論文審査の要旨（2000 字程度）

This dissertation entitled “Study on the Fabrication of Conducting Polymer Materials by AC and Pulsed Bipolar Electropolymerization” focuses on the conducting polymer fiber from the ends of the bipolar electrode (BPE) in a wireless manner, especially in high viscosity and high ionic concentration conditions.

Chapter 1, “General introduction,” introduces the principle of bipolar electrochemistry. Based on the alternating current (AC)-bipolar electropolymerization system in dilute electrolyte developed so far, the possibility of controlling the morphology of product polymer fibers by using concentrated electrolyte or pulsed electropolymerization is described.

Chapter 2, “Bipolar Electropolymerization in Ionic Liquids”, demonstrates the AC-bipolar electropolymerization of EDOT in three ionic liquids (ILs): [DEME][BF_4], [EMIM][BF_4], and [DEME][TFSI]. The differences in the deposited PEDOT morphologies (cluster, film and fiber) are discussed in terms of the physicochemical properties of the three ILs, such as electric field transmission efficiency (EFTE) and diffusion coefficient. Notably, [DEME][TFSI], with intermediate EFTE and diffusion coefficient values among the three ILs yields linear PEDOT fibers, similarly to the morphology observed in the previous report using a dilute electrolyte solution. The use of ILs is an ideal approach for environmentally friendly electrosynthesis of conductive polymers.

Chapter 3, “Bipolar Electrosynthesis in Concentrated Electrolyte”, describes a bipolar electrolytic system with highly concentrated electrolytes that provides the ability to adjust viscosity by changing the concentration of the supporting electrolyte. This system offers greater flexibility than ionic liquids in enhancing or weakening the electrophoresis effect and diffusion of the cationic species of the generated PEDOT. The fiber propagation in the concentrated electrolyte system is faster than that in ILs, and the fiber diameter is slightly thinner than that in ILs, suggesting that the PEDOT growth behavior can be controlled by electrolyte concentration. The conductivity of the PEDOT fibers obtained in the concentrated electrolyte is similar to that in the dilute electrolyte.

Chapter 4, “Pulsed Bipolar Electropolymerization”, aims to fabricate the PEDOT fibers with highly doped state. The pulsed direct current (PDC) bipolar electrochemical system is effective to realize unidirectional growth of the PEDOT fiber and maintain the fibers in the oxidized state. The fiber growth mechanism in the PDC bipolar electropolymerization is discussed These studies are expected to contribute to a better understanding of the fine tuning of the bipolar electrochemical deposition process.

Chapter 5, “General Conclusion”, summarizes the PEDOT fiber formation strategy in the BPE systems, which has been successfully applied to different electrolyte systems with low and high viscosities. The findings in this research contribute to the future development of both conductive polymer chemistry and bipolar electrochemistry. Therefore, it is recognized that this dissertation is of sufficient value as a doctoral thesis.