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Physics : Soft and Granular Matter, Complex Fluids and Microfluidics

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Electro-Osmosis of Polymer Solutions

Linear and Nonlinear Behavior

- Nominated as an outstanding contribution by Kyoto University in 2016
- Introduces chemical physics of electrolyte solutions
- Provides a comprehensive guide to electro-kinetics for researchers in soft matter physics
- Explains electrophoretic mobility reversal and nonlinear electro-osmosis in polymer solutions simply and qualitatively

This thesis focuses on the theoretical description of electro-osmosis of polymer solutions. In particular, it emphasizes the importance of considering non-uniform profiles of the solution viscosity and polymer concentration near a solid surface. The thesis begins with an introduction to fundamental theories and experimental observations for beginners in this field, concerning electrolyte solutions, electric double layers, and electrokinetics. In Chapter 2, the author discusses the linear response of electro-osmotic flow with respect to applied electric fields in aqueous polyelectrolyte solutions, and predicts a possibility of flow reversal caused by oppositely charged polyelectrolytes adsorbed on a charged surface. In Chapter 3, the author extends the discussion to non-linear electro-osmotic flow driven by applied electric fields in neutral polymer solutions. The dynamics of polymers are modeled and simulated using Brownian dynamics and kinetic theory. Finally, the thesis is summarized in Chapter 4. The introduction provides a comprehensive review of electrokinetics for graduate students and researchers interested in soft matter physics. An additional attraction is that readers can effectively learn various theoretical approaches to electro-osmosis.

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