MASTER'S THESIS

Study of hydrodynamic coupling and interfacial property in emulsion system

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Study of Hydrodynamic Coupling and Interfacial Property in Emulsion System

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Abstract

In this thesis, experimental studies of the hydrodynamic coupling between two rotating colloidal particles and the properties of the surfactant self-assembly monolayers (SAM) at oil-water interface are described. By a two-step emulsification process, we are able to encapsulate a micron-sized birefringence liquid crystal (LC) particle inside an aqueous droplet, which is in turn freely suspended in oil environment. Using optical tweezers, we have successfully achieved the trapping and rotating of the internal LC particle. Due to hydrodynamic interactions, the rotation of the LC particle induces a rotation of the host droplet. When the LC particle rotates at a trapping position inside the aqueous droplet, we find that there exist two stable configurations for the two rotating objects. One is the concentric motion, where the center of the host droplet coincides with that of the LC particle; the other is the LC particle stays against the inner wall of the rotating host droplet. In the latter configuration, the suspended droplet is found to execute a complex motion, a combination of spin and revolution around the LC particle. We have studied experimentally the stability of the rotation under various conditions, and by varying the rotational speed and size ratio of the two objects, a dynamic transition from revolution to spin has been observed for the rotation of the host droplet.

With the help of optical tweezers, the rotating LC particle can be pushed against the surfactant SAM at the droplet's inner boundary. The micro-sized LC particle is used as a probe to examine flow properties at the fluid-fluid boundary. By studying the motion of the LC particle and SAM, a novel method to obtain the friction property of the interface coated with different SAMs is presented. In addition, some viscoelastic properties and the state of the surfactant monolayer are discussed in this paper through the investigation of the interaction of the LC particle and the SAM.

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