Direct measurements of heterogeneous capillary interactions between ellipsoid particles at an oil-water interface via optical laser tweezers

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Typical colloidal particles are strongly and irreversibly attached to fluid-fluid interfaces due to the reduction of a surface free energy. The colloidal particles laid at the oil-water interface exhibit distinguished behaviors with those dispersed in a single fluid phase, because of competitive interactions between the electrostatic interactions caused by the asymmetric surface charge distribution across the fluid interface and the capillary interactions resulting from the interface deformation. In the case when particles lying at the interface are chemically and/or geometrically anisotropic, the capillary interactions become dominant compared to the electrostatic interactions, leading to the formation of percolated network structures. Previously, the capillary interactions in long-range separations between ellipsoidal particles at the interface were quantitatively measured using the trap-release method, whereas the measurements of short range interactions were extremely challenging due to their rotational motion. In this work, we demonstrate a new protocol to directly measure the heterogeneous capillary interactions over short-range separations via optical laser tweezers.