Electric Field-Induced Deformation of Particle-Laden Drops and Structuring of Surface Particles

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Abstract : Drops covered by particles have found important uses in various fields, ranging from stabilization of emulsions to production of new advanced materials. Particles at drop interfaces can be interlocked to form solid capsules with properties tailored for a myriad of applications. Despite the huge potential of particle-laden drops and capsules, the knowledge of their deformation and stability are limited. In this regard, we contribute with experimental studies on the deformation and manipulation of silicone oil drops covered with micrometer-sized particles subjected to electric fields. A mixture of silicone oil and particles were immersed in castor oil using a mechanical pipette, forming millimeter sized drops. The particles moved and adsorbed at the drop interfaces by sedimentation, and were structured at the interface by electric field-induced electrohydrodynamic flows. When applying a direct current electric field, free charges accumulated at the drop interfaces, yielding electric stress that deformed the drops. In our experiments, we investigated how particle properties affected drop deformation, break-up, and particle structuring. We found that by increasing the size of weakly-conductive clay particles, the drop shape can go from compressed to stretched out in the direction of the electric field. Increasing the particle size and electrical properties were also found to weaken electrohydrodynamic flows, induce break-up of drops at weaker electric field strengths and structure particles in chains. These particle parameters determine the dipolar force between the interfacial particles, which can yield particle chaining. We conclude that the balance between particle chaining and electrohydrodynamic flows governs the observed drop mechanics.

Keywords : drop deformation, electric field induced stress, electrohydrodynamic flows, particle structuring at drop interfaces
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