Surfactant-Covered Drop Electrohydrodynamics

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We consider 3D drops covered by an insoluble surfactant and immersed in a liquid with different viscosity subjected to external flow and under the influence of an electric field. Surfactants (surface active agents) are compounds that lower the surface tension between liquids and they are widely used in engineering applications, in pharmaceuticals, foods and petroleum industries. Electric fields are used to manipulate drops in several applications: biomedical applications such as separation and detection (for example of infected blood cells, DNA and protein molecules), selective manipulation, drug delivery and so on; other engineering applications are represented by mixed emulsions where a specific material needs to be isolated. It is then clear the increasing need of designing biotechnological devices for such purposes and how fundamental is to understand the physics of these systems.
The dynamic of the drops is governed by the Stokes equations coupled with the electric potential equation and the surface convective-diffusion equation for the evolution of the surfactant concentration. With the large surface to volume ratio of these drops, the dynamics at the interface become extremely important and it is very natural to consider integral equations for this problem.
The proposed method [1] is able to simulate 3D drops with different viscosities and close interactions; a special reparameterization method is introduced to maintain a high-quality representation of the drops also under deformation and the adaptive time stepping scheme for the coupled drop and surfactant evolution is designed with special attention to the implicit treatment of the surfactant diffusion. Preliminary numerical results showing the effect of the electric field will be shown.

References

[1] Sorgentone, C. and Tornberg, A.-K. 2018 *A highly accurate boundary integral equation method for surfactant-laden drops in 3D* Journal of Computational Physics 360 p. 167-191.