A LATTICE-BOLTZMANN MODEL OF ELECTROCAPILLARITY

É. Ruiz-Gutiérrez[1], G. McHale[1] and R. Ledesma-Aguilar[1]

[1]Northumbria University, Newcastle upon Tyne, UK

elfego.r.gutierrez@northumbria.ac.uk

Dielectrophoresis and electrowetting have become widely used techniques for controlling and manipulating small amounts of liquids. Applications of dielectrophoresis include the transport, and separation of liquids and other particles of different electric permittivity. Examples of electrowetting applications are electronic paper displays, adjustable lenses, and lab-on-a-chip devices.[1,2] In both cases, the underlying phenomena can be encompassed under electrocapillarity, the interaction of electric fields with multiphase systems where the effects of surface tension are comparable with electrostatic forces. Usually, one of the phases is a conducting liquid surrounded by an ambient dielectric or two liquids of different electric permittivities. Fundamental aspects in electrocapillarity are still open for investigation; this mainly concerns the dynamical aspects, for example, the motion of contact lines and the shape that the liquid interface acquire in the presence of electric stresses.[2,3] This is important since most of the applications rely a precise control of the liquids and by placing electrodes in clever arrays. Simulations on electrocapillarity are timely as they may provide insights to address these aspects. In this contribution, we propose a simple lattice-Boltzmann method that is capable of simulating electrocapillarity. We use a binary fluid model that includes capillary phenomena and extend the algorithm to include the forces produced by electric fields. The electric field and the charges are derived from a potential function, which we obtain by a relaxation method.[4] We first validate our method by comparison against the experimental observations. Then, we examine the morphology of droplets under dielectrophoretic stresses.

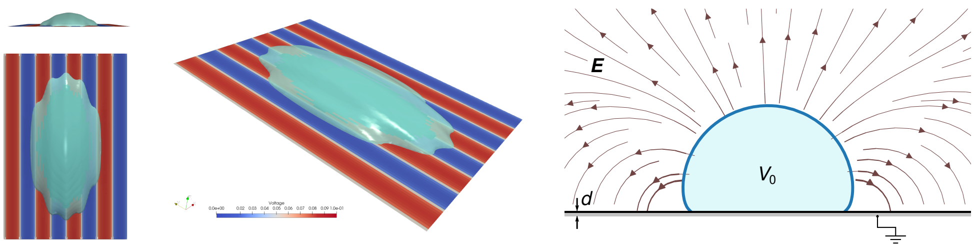

Figure 1: Example of simulations of droplet spreading by dielectrophoretic forces (left) and electrowetting (right).

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