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Lattice Boltzmann Modeling of Two-Phase Electrohydrodynamic (EHD) Flows

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Extended Abstract

Two-phase electrohydrodynamic (EHD) flows [1] are the basic problems in many fields, such as electro-hydrodynamic conduction pumping, heat transfer of electronic components and electrospray ionization, which are also the research highlights in recent years. The lattice Boltzmann method is a class of mesoscopic approaches that has been developed into an effective numerical scheme for simulating multiphase flows [2]. This paper concentrates on further development of lattice Boltzmann method for the two-phase EHD flows problem. The lattice Boltzmann models of Zu et al. [3,4] are developed to solve the phase field for interface tracking and the flow field for hydrodynamic properties. While, the model of Liu et al. [1] is used to solve the electric field for electrical potential distribution. The two-dimensional deformation of a single bubble and multi-bubbles under a uniform electric field is considered. For the single bubble deformation, the numerical results obtained by the present LB model are compared with those of previous theoretical and numerical studies through investigating conductivities and permittivities ratio of two fluids ($R=\sigma_l/\sigma_m$, $S=\varepsilon_l/\varepsilon_m$) influence on bubble deformation. Furthermore, influence of viscosities ratio of two fluids ($B=\mu_l/\mu_m$) on the bubble deformation is investigated in detail. The results show that the present LB model is in good agreement with the previous studies and the parameter B has little influence on bubble deformation. For multi- bubbles, the behavior of bubbles under different electric field intensity is observed. In addition, the process of bubble coalescence dominated by electric field are analysed. This study contributes to reinforcing the understanding of the two-phase EHD flows mechanism and has a guiding significance for industrial applications.

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