Electrotunable Charge Separation and Its Effect on Dynamic Wetting

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Recent studies have shown that the dynamic wetting of a moving droplet on an inclined surface can be significantly influenced by slide electrification [1]. During sliding, disruption of the electrical double layer at the solid–liquid interface leads to charge separation, leaving opposite charges within the droplet and on the solid surface at the rear of the drop [2]. The deposited surface charge can, in turn, affect droplet motion and wetting behavior [1, 3]. Previous work [4] has further demonstrated that, as charge accumulates, the droplet potential increases and eventually reaches a saturation value on the order of several kilovolts. These findings raise a central question: can charge separation be actively controlled by applying an external potential to the droplet?
In this study, we address this question by applying a defined electrical potential to a droplet sliding on an inclined surface and systematically investigating the resulting dynamic wetting behavior. The droplet velocity and acceleration under different applied potentials are measured and correlated with charge separation. The electrostatic interactions arising from deposited surface charges are quantified to evaluate their contribution to droplet motion. In addition, the influence of deposited charge on solid surface energy and dynamic contact angles is analyzed. This work provides a strategy to actively control droplet motion and wetting behavior through modulation of the applied droplet potential.

Keywords:
slide electrification, electrical double layer, dynamic wetting, electrowetting

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