Abstract

The study enumerates the roles engineered elastomers, specifically unidirectionally structured surfaces, play in microfluidic applications. Facile fabrication of unidirectionally structured hydrophobic surfaces is achieved and the effects of the substrate anisotropy tend to decide the wetting state (complete or composite) during electrowetting on dielectric (EWOD). It has been shown that the initial composite wetting states are suitable for faster spreading at lower voltages, whereas the complete wetting states yield higher anisotropic spreading and better directional maneuverability of the droplets. The experimental findings are attributed to the additional capillary wicking associated with the underlying micro ridges which act as micro capillaries for complete wetting, unlike the presence of air gaps in the composite wetting states. Thus substrate anisotropy can be tuned as a process parameter in manipulating the directional wetting and mobility of droplets. In the second part, unidirectionally structured tailored topography is achieved by varying the elastic modulus and loss modulus of the substrate by creating controlled substrate temperature gradient followed by oxygen plasma treatment along a PDMS substrate. The role of the variation of substrate feature sizes, hydrophobic recovery and substrate wettability on the deformation and movement of the droplet are probed in detail. The last part of the study describes the effect of microstructures on droplet impact dynamics and explores the details of the contact line pinning on wrinkled substrates. The excess rebound energy has been evaluated as functions of the contact angle and the maximum spreading diameter and is used to characterize droplet impact, initial spreading and the partial rebound phenomena.

Keywords: Wrinkles, wettability, elasticity gradient, tailored topography, EWOD, contact line, drop impact dynamics.