A finite-element method model for droplets moving down a hydrophobic surface

We set up a 2D computational Finite-Element Method (FEM) model describing the initial descent of a droplet down an inclined hydrophobic substrate. We solve the full Navier-Stokes equations inside the drop domain, and use the arbitrary Lagrangian-Eulerian method to keep track of the droplet surface. The contact angle is included by using the Frennet-Serret equations. We investigate the behaviour of the drop velocity as a function of the slip length and compare with experimental results. Furthermore, we quantify the energy associated with centre-of-mass translation and internal fluid motion, and we also compute the local dissipation of energy inside the drop. The model predicts trajectories for tracer particles deposited inside the drop, and satisfactorily describes the sliding motion of steadily accelerating droplets. The model can be used for determining a characteristic slip parameter, associated with slip lengths and drag reduction for hydrophobic surfaces.