Geometric effects on electrocapillarity in nanochannels with overlapped electric double layer

이정아, 강인석†
포항공과대학교
(iskang@postech.ac.kr†)

Electrocapillarity (or electrowetting) originated from the surface energy change due to an external electric potential has been regarded as an efficient tool in micro/nanofluidics. Especially in nanochannels, an overlapped electric double layer (EDL) of electrolyte solution is formed as the gap size becomes comparable with the EDL. Poisson-Boltzmann (PB) equation is adopted which is a widely accepted theory to describe the electric potential distribution of electrolyte solution. Total stress from the overlapped EDL is expressed by the sum of electric stress from Maxwell stress tensor and the osmotic pressure due to the ionic concentration. This total stress exhibits a collective electrocapillarity at the interface between gas and liquid. To see the geometric effects, three dimensional nanochannels with two dimensional cross sectional shapes are studied. Several equilateral polygons are numerically analyzed to obtain the total pressure and they show consistent total pressure when the hydraulic diameters are unified. Also, for a fixed hydraulic diameter, analytic solutions from the linearized PB equation well match with the numerical results when the dimensionless number κh is bigger than the O(1) and the surface potential is comparable with thermal voltage, $k_B T/ze$.