Shear-rate dependent hydrodynamic slip in microfluidic channels

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Microfluidic devices conduct various chip-based chemical and biological analyses. Hydrodynamic slip at the interface between fluids and the channel wall is informative data for designing the effective flow distribution and flow control in the microfluidic chip. We consider a nonlinear effect of electric double layer in the fluid motion to develop a framework that is used to accurately identify hydrodynamic boundary condition from velocity profile data. We fabricate a microfluidic chip made of hydrophobic polydimethylsiloxane (PDMS) which exhibit the non-wetting and wall slip of Newtonian fluids. Then, velocity profiles with variations of shear rate are directly observed by using a fluorescence microscope on the basis of particle streak velocimetry. Experimental data are analyzed by means of the collective imaging of microfluidic tracer developed in this study. We quantify the change of slip length with increasing shear rate.