Masters Defense

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ELECTROKINETIC INSTABILITIES OF NON DILUTE COLLOIDAL SUSPENSIONS

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Abstract

An experimental investigation of electrokinetic instabilities of non-dilute colloidal suspensions in microchannels is presented. The addition of charged colloidal particles to a solution can alter the solution's electrical conductivity, permittivity as well as the average particle electrophoretic mobility. In this work, a colloidal volume fraction gradient is achieved at the intersection of a Y-shaped Poly Di-Methyl Siloxane (PDMS) microchannel. The flow becomes unstable when the electroviscous stretching and folding of the conductivity and permittivity interfaces exceeds the dissipative effects of viscous forces and particle diffusion. The suspension conductivity and the particle mobility as a function of the particle (500 nm polystyrene) volume fraction are presented. The critical conditions required for flow instability are measured and compared with a scaling analysis which indicates that the flow becomes unstable at a critical electric Rayleigh number of Ra_e = 3.4e5 for a wide range of applied electric fields spanning three orders of magnitude and colloid volume fractions varying two orders of magnitude. The scaling analysis also shows that the flow becomes unstable due to a coupling between applied electric fields and the electrical conductivity and permittivity gradients in the flow. Electrokinetic instabilities of non-dilute colloidal suspensions may be important for applications, such as the electrophoretic deposition of micropatterned colloidal assemblies, electrorheological devices, and on-chip electrokinetic manipulation of colloids.