Fluid transport in free liquid films

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This paper reports on the electroosmotic flow profiles in a suspended liquid film stabilized with both cationic and anionic surfactants. Experimental velocity profiles were measured using confocal micro-PIV (micron-resolution Particle Image Velocimetry). It was found that the resultant flow field mainly depends on the type of the surfactant used as the shape of the film and the zeta potentials at the gas-liquid and solid-liquid interfaces are affected by the characteristics of the surfactant molecules. A computational model was also developed to predict the flow field in this system and was verified using the experimental measurements.

Foam consists of large number of liquid lamella that gives rise to processes that depends on surface phenomena and application of an electric field leads to interesting flow patterns within the foam structure that could lead to new applications. In recent years, electric field interactions with free suspended films/soap films have gained significant interest. Recent work includes liquid film motors, [1] and reverse drainage of a cylindrical foam column, [2]. The main purpose of this study is to determine the flow field within a suspended foam film as a result of electro kinetic phenomena and to investigate the effect of surfactant type on the flow features with the view of finding new applications for micro/nano fluidics.

A liquid film holder is fabricated by connecting two clear borosilicate glass rods with two platinized titanium rod. A liquid film was suspended in the frame by pipetting a small volume of the test solution made of deionized water, glycerol, phosphate buffer and surfactant and carefully dispensing it to the cavity of the holder to make a thin film. The liquid film was in direct contact with the electrode and the glass rods and takes the shape of a liquid lamella observed in foam (see Figure 1). By applying an electric field of 1250 V/m across the liquid film, a flow field was established using electroosmotic flow. The resultant flow field within the cell was measure by confocal micro-PIV (micron- resolution Particle Image Velocimetry) using 1 micron polystyrene latex (PSL) particles. In order to account for electrophoresis of the flow visualization particles, electrophoretic mobility of the particles in the test solution were measured using Malvern Zetasizer Nano-ZS.

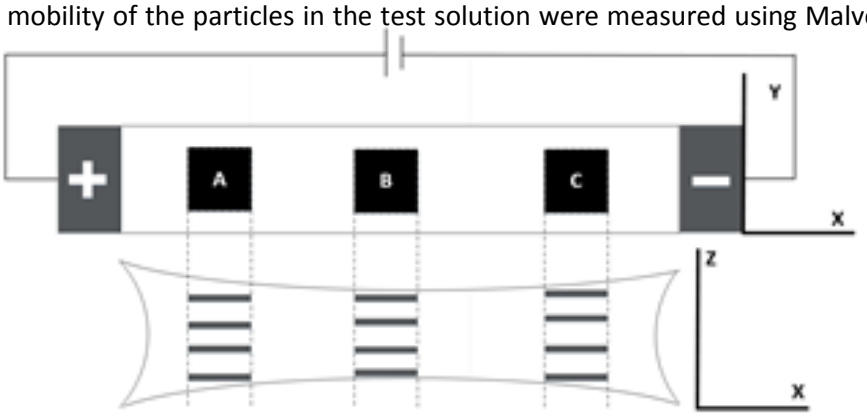

Figure 1 A schematic representation of the liquid film showing the velocity measurement locations (top view). Region A is 700 µm from the cathode; region B is at the mid-section of the film and C is 700 µm from the anode electrode. The lower image shows the end elevation of the film where depth wise velocity profiles were measured.

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[2] O. Bonhomme, O. Liot, A.L. Biance, L. Bocquet, Phys. Rev. Lett., 2013, **110** (5), 054502.