STABILITY OF AN ELECTROHYDRODYNAMIC LIQUID BRIDGE

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Micrometer size filaments can be generated from millimeter size nozzles upon application of an electric potential to a pendant drop. With many liquids, the drop deforms into a Taylor cone whereupon a thin jet forms due to charge accumulation at the tip of the cone. With polymeric liquids, elastic stresses may also play significant roles [2]. When a counter electrode is placed a short distance below the nozzle and fluid supplied from a reservoir, an intact jet may span the space between the nozzle and the electrode. This is an electrohydrodynamic liquid bridge. If the bridge is stable, the stagnation point can be moved across the electrode surface to deploy small features (electrohydrodynamic printing). Polymeric mixtures and suspensions can be deployed at meter per second speeds with features as small as 100 nm [3]. One challenge is to avoid charge-driven, non-axisymmetric oscillations of the electrohydrodynamic filament since sideways motions dictate the fidelity of the printing.

The main cause of oscillations is electric charge on the bridge surface [4] that causes the filament to whip about, as in electrospinning [5]. Using a parallel plate electrode configuration and a fast imaging system, we investigated the character of non-axisymmetric oscillations and found, among other things, a dramatic damping of the oscillation amplitude at a 'critical' electrode separation. The character of the oscillations for viscoelastic liquids differs from that of Newtonian liquids. The paper will report the results of an extensive set of experimental observations.

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