Free Surface Electrospinning from a Wire Electrode

Keith M. Forward and Gregory C. Rutledge
Department of Chemical Engineering
Novartis-MIT Center for Continuous Manufacturing
Massachusetts Institute of Technology
Cambridge, MA 02139

***Abstract*— The needle or nozzle-based electrospinning process has long been explored for its capability to produce unique nanofiber materials with high surface area and high porosity while being able to operate at relatively low cost compared to other techniques for the manufacture of nano-materials. These materials have the possibility to impact a wide range of fields such as textiles, filtration, tissue engineering, drug delivery systems, nanocomposites, and alternative-energy generation systems such as solar cells, fuel cells, and energy storage devices. However, the production rate of needle-based electrospinning is rather low, which limits its ability to be industrialized and applied in large scale manufacturing. For this reason, new techniques are being investigated to increase the throughput where jetting occurs off a free liquid surface without the aid of a needle or nozzle, which we refer to as "free surface electrospinning." In free surface electrospinning, jets self-organize along the free liquid surface. We study a system where a wire electrode is rotating horizontally through a charged polymeric bath, resulting in Taylor cone formation from the entrainment fluid. A correlation for fluid entrainment is presented to predict estimated limits of productivity. The electric field of the system is modeled to decouple jetting behavior and the geometry of the system. The productivity is determined for a range of applied voltages and electrode rotation rates, and compared to the theoretical limit of liquid entrainment. In addition, scanning electron micrographs are used to investigate the fiber diameter and distribution of the electrospun mats.**
[1]