Analysis of Size and Electrostatic Charge Distributions of Electrosprayed Droplets

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***Abstract*— Size and charge distribution measurements were made simultaneously using a laser Doppler velocimeter (LDV) and an electrical mobility analyzer on electrosprayed water droplets terminally settling under gravity in an enclosed chamber. The electrosprayed droplets consisted of a 4:1 solution of distilled water and 99% isopropyl alcohol, which reduced the surface tension of pure distilled water enough such that electrospray from a needle-to-disk electrode configuration could be maintained in the stable Taylor jet cone mode for the duration of testing at a voltage not conducive to arcing or corona discharge. The electrospray setup was oriented such that the droplets fell vertically, and the LDV used to measure the droplet velocity was positioned with its sensing volume located at a point where the droplets reached their terminal settling velocity. Droplet size measurements were determined from the terminal settling velocities through an iterative program matching the calculated velocity with the appropriate Reynolds number.**

The measurement of the net charge-to- mass ratio (Q/M) was made by placing a Faraday Cage filter underneath the LDV sensing volume so that the filter can collect the charged droplets emitted by the needle. The Faraday Cage was connected to an electrometer for measuring the charge accumulation as a function of time. The total mass of the water droplets was determined from the volumetric flow rate of water passing through the syringe pump used for feeding the water-alcohol solution to the needle.

Alternatively, the charge distribution of the droplets was measured by replacing the Faraday cage filter with a charge mobility analyzer. After passing through the LDV probe volume, the charged droplets were passed through a horizontal electric field created by two parallel plates. Under this conditions, each droplet experiences two orthogonal fields: (1) gravitational field under which the droplet moves vertically downward with its terminal settling velocity depending upon its mass and (2) a transverse electric field causing it to move in the horizontal direction with its electrical terminal velocity depending upon its electrical charge q. Charge distribution measurements were enabled by discretizing each of the parallel plates into eight identical rectangular plates. The total charge accumulated on each of the 16 individual plates produced a proportional output voltage from a charge amplifier circuit, allowing for a charge histogram to be constructed. The experimental design, its application to the synthesis of nanostructured photoanodes for hydrogen generation, and the preliminary results are presented.