Electrospray System

A unique method for simultaneous optimization of electrospray parameters.

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**BRIEF DESCRIPTION**

These innovations provide new methods and systems related to the electrospraying of liquids. Electrospraying is the process in which particles of sizes in the micro and nanometer range are simultaneously generated and charged by means of an applied electrostatic field. These processes can be carried out in an ambient atmosphere, without the use of any complex reactors and vacuum chambers usually necessary for most of the conventional methods. One of the primary limitations of electrospraying is corona discharges. The effects of corona discharges have not been studied quantitatively, and motivated our studies. Understanding the corona discharge thresholds associated with electrospraying, applications could be optimized. These are the first models for the calculation of electrospraying corona thresholds.

A new method to determine surface tension using electrospraying is also offered. The unique feature of this method is its ability to do measurements at arbitrary temperatures. The determination of these two physical properties simultaneously, under the same conditions, is a first, as previously it was only possible to determine these properties independently. This adds value to propulsion based systems, as it was previously difficult to measure the propellant response in an operational environment. Knowledge of the finite amount of time required for the electrospraying to initiate also allows optimal design for the needs of the given application.

**TARGET MARKET**

- Manufacturers of analytical apparatuses
- Chemical and polymer science industry
- Manufacturers of medical nebulizers
- Manufacturers of advanced printers
- Space propulsion industry

**VALUE PROPOSITION/BENEFITS**

- The dynamics of electrostatic ion thrusters are much better understood.
- Powder production by means of electrospraying can be optimized.
- Pattern generation using pulsed electrospraying cone-jets can be optimized.
- Knowledge of the finite amount of time required for the electrospraying to initiate, allows optimal design for the needs of the given application.
- Allows the design of a thruster for any given propellant, by means of doing a multi-dimensional optimization.
- For existing thrusters, an analysis can be done to determine which propellants will perform best, without the need for trail-and-error studies.
- Eases the process of doing performance characterization.

**UNIQUE CHARACTERISTICS**

New method using electrospray ionisation to determine the surface tension of a liquid. Determination of surface tension and density simultaneously, under the same conditions. Methods to design electrospray systems in an optimal manner without the need for empirical trail-and-error approaches. Systems can be manufactured and sold as standalone units. Uses an exceptionally small sample size (between 2 and 20 µl, a fraction of that used by current surface tension measurement methods). Provides measurements with an improved accuracy and fast measurement times - less than 3 minutes per sample. The system has low operation and maintenance costs. For electrostatic printing, both the droplet size and spacing can be adjusted by applying pulsed voltages of different frequencies, allowing complete control by means of electrostatics as opposed to translation control of a stage.

**TECHNICAL DESCRIPTION**

Surface tension is a term that describes the tension that results from cohesive forces between liquid molecules at an interface between the liquid and a gas. The system employs electricity to obtain an electrospray of fine, highly charged droplets of liquid. A voltage is applied to the liquid such that it is channelled through the capillary and emitted through an aperture in the capillary. The electrostatic potential between the capillary and an external electrode results in the formation of a fine spray of highly charged droplets of liquid. The formation of the spray is associated with the measurement of surface tension and simultaneous determination of the density.

The majority of electrostatic ion thrusters and pulsed powder production applications of the past few decades were studied by trail-and-error. The current result addressed this problem by looking at the two most problematic factors associated with electrospraying applications: (1) the maximum electric field that can be applied before corona discharges destabilize the Taylor-cone or destroy the capillary and (2) the time that is required for the Taylor-cone to form. Knowledge of these maximum electric fields for a given geometry and sample enables the user to determine the range of operational parameters beforehand. This not only reduces the experimental time requirement during the research and development stage, but it also allows for multi-dimensional optimization in terms of the given geometry or the physical and chemical properties of the sample.