National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Mechanical and Fluid Systems

Miniaturized Electrospray System

An Efficient, Low-Power, Precise Electrostatic Sprayer

Innovators at NASA's John F. Kennedy Space Center have developed a miniaturized electrospray system that electrostatically charges and delivers liquids to grounded targets. The technology was developed as an alternative to existing options for in-space aeroponic food production applications. Typically, agricultural electrosprayers are large, high liquid-consumption devices that rely on pressurized gases to forcefully transport charged droplets up to 25 feet away from the nozzle. These existing electrosprayers are not ideal for precision applications in space. To meet this need, a miniaturized electrosprayer was created that requires only a liquid source, a nebulizing nozzle, a metallic ring positioned at the nozzle orifice, and power supply to energize the ring to facilitate droplet charging. Potential applications for the new technology include those where electrospray systems are currently employed like small-scale delivery of antimicrobial coatings (e.g., for COVID-19 disinfection), optical coatings, paint, nutrients, pesticides, water (e.g., for aeroponics), and more.

BENEFITS

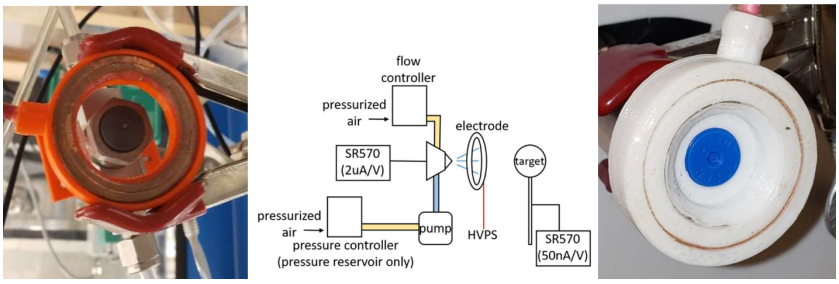
- No air assistance required: Many existing electrosprayers rely on pressurized air to transport charged droplets, which necessitates high voltage reservoirs or continuous manual pressurization for operation. NASA's electrosprayer has low power requirements that can be satisfied with AAA batteries
- Precision: The system accurately concentrates a mist of liquid at spray distances of less than 2 ft. This enables application in enclosed environments and conserves liquid consumption - potentially valuable in situations where liquid is expensive and/or scarce
- Efficiency: NASA's electrosprayer provides ~90% coverage efficiency and has a charge-to-mass ratio of ~12 mC/kg
- Form factor: NASA's electrosprayer is highly miniaturized, enabling its potential integration into handheld devices (e.g., spray bottles for disinfecting surfaces)

THE TECHNOLOGY

NASA's miniaturized electrosprayer offers a new technology that may support the next generation of portable and/or of precise electrosprayers. Developed for applying water to plants in space where gravimetric methods do not apply, this sprayer may also enable the delivery of a precise liquid for terrestrial uses without relying on pressurized air.

Electrospraying (aka electrostatic spraying) is a technique where droplets are charged to enhance surface adhesion and coverage efficiency. Various electrospray variants are used in a host of industries to coat auto parts, apply pesticides and nutrients to crops, and more. Commercially-available electrosprayers are generally large, air-assisted devices that traverse up to 20 feet in the air and require large amounts of liquid and electrical power.

NASA's miniaturized electrosprayer system does not require compressed air, uses far less liquid, and concentrates the mist in an area less than 2 feet away. The system only needs enough power to charge the droplets at the spray nozzle, so it may use small batteries (e.g., AAA batteries). The new electrosprayer implements a unique nozzle design that imparts a high charge-to-mass ratio on the spray and increases coverage efficiency. Thus, the miniaturized electrosprayer can be placed inside a portable, handheld sprayer or be used as a stationary device for a wide range of uses, particularly when spraying expensive chemicals (e.g., plant nutrients) and when precise, efficient spraying is required (e.g., industrial coatings, disinfectants, etc.).



(Left) A traditional industry nozzle using compressed air and compressed fluid atomized into fine droplets. The setup is more complicated for space applications. (Center) Experimental setup for measuring generated current as well as deposited charge to mass on the target; (Right) NASA's electrosprayer prototype (does not use pressurized air). Using the mister nozzle, NASA inventors were able to produce the same droplet distribution as the air assisted nozzle but with a less complicated, miniatured electrospray system.

APPLICATIONS

The technology has several potential applications:

- Aerospace and Aviation: eletrospraying vehicle components with specialized coatings
- Agricultural: efficient application of water/pesticides/nutrients for aeroponics and hydroponics systems; systems for water conservation (e.g., in arid environments)
- Coatings: applying coatings in confined spaces or sealed volumes
- Consumer goods: spraying paint, pesticides, disinfectants, etc.
- Health and Wellness: spraying antimicrobial coatings (e.g., for COVID-19 disinfection)
- Medical devices: delivering topical medications
- Nanomaterials: precise application of coatings
- Optics: precise application of optical coatings

PUBLICATIONS

Patent No: 11,793,130

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