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Author: Mr. Bryan Llumiquinga
Rutgers University, United States, bdl52@scarletmail.rutgers.edu

STATICAPONIC LOW WASTE PLANT NOURISHMENT

Abstract

Electrospray deposition (ESD) is a spray coating technique that applies a high voltage to atomize a solution flowing through a conducive nozzle into a fine spray of charged microdroplets. In ESD, emitted droplets result from an electrostatic breakdown from an electrostatically drawn Taylor cone. At the cone tip, a microjet ejects a plume of droplets when a critical charge density occurs. These self-repulsive droplets undergo Coulombic fission to decrease the ratio of charge to the surface area, resulting in a monodisperse spray of microdroplets. Through ESD, water and nutrients can be supplied directly to plants' roots in a micro-gravity environment. Previous techniques such as aeroponics use a similar approach, however resource waste is still occurring. Using ESD, the reduction of resource consumption and maximizing the growing process's efficiency is possible by having the water and nutrients be delivered directly onto the root of the plants. Designed around ESD, a plant growth system allowed the plants' roots to be suspended, held by a solid media, and sprayed. This system was coined 'Staticaponics' as it combines the applications of aeroponics and ESD. Due to the large surface tension of water, very high voltages enable a stable spray. However, the use of high voltage required to break through water's surface tension can often lead to corona discharge if the voltage becomes greater than the electric breakdown threshold of its surrounding gaseous medium. A hemispherical extender cap (6mm diameter) was fabricated out of acrylic and installed about 1 mm below the needle. This extender cap enhances the cone jet's stability for a wide range of flow rates and applied voltages by manipulating the electric field near the nozzle and changing the solution droplet's shape. With the extender cap, a liquid solution without an electric field interacts with the cap's outer wall and reshapes the droplet. This interaction is maintained even after an electric field is introduced and a cone-jet forms. Experiments have shown that the extender cap results in much broader stability of the cone-jet mode when compared to simple nozzles for high flow rates (¿15 mL/hr), even with the inclusion of ionic plant foods that might otherwise destabilize spray. Using the extender cap and ESD implementation, a highly accurate target delivery system suitable for plant growth in micro-gravity is established.