

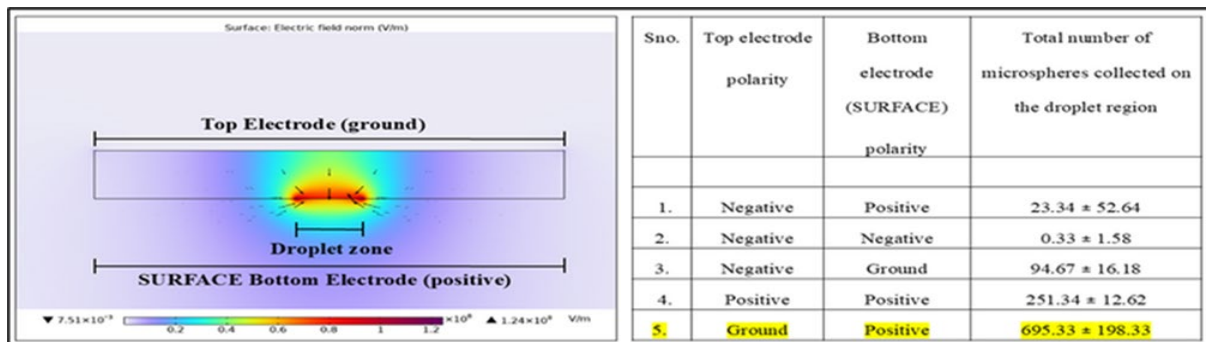
Modifying the Electric Field for Localised Deposition of Aerosols

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Abstract:

Aerosols, comprising suspended solid and liquid phases within gaseous media, pose significant health and environmental challenges. Their impact ranges from affecting the respiratory and cardiovascular systems to alterations in cloud formation processes and global temperature regulation mechanisms. Characterising and understanding airborne particulate matter is becoming increasingly important in understanding risks and mitigating exposure. This project focuses on developing a novel Wet Electrostatic Precipitator (WESP) that charges both aerosols and microfluidic liquid droplets to facilitate the collection of the charged aerosols into the oppositely charged droplets. This approach is intended to yield highly concentrated aerosol samples, which can be used for direct, rapid, downstream analysis. Furthermore, it provides a step towards a next-generation aerosol collector for a preemptive early detection system for air monitoring applications. The WESP operates based upon classical Electrostatic Precipitator (ESP) principles, utilising Coulomb's law to move charged particles from a conductive top electrode towards a collection electrode plate. A custom collection electrode plate was fabricated, combining conductive and dielectric materials to create a localised droplet charging region and enable particle collection within the area. Prior to introducing microfluidic droplets, ESP electrode configurations were tested to identify electric field setups that optimised particle collection at the droplet site. WESP collection optimisation was verified through COMSOL Multiphysics computational simulations. Finally, experimental testing demonstrated successful collection of charged aerosol particles into charged liquid droplets. The WESP prototype represents an advancement in aerosol collection and provides a functional platform for future real-time environmental monitoring applications.



Keywords: Wet Electrostatic Precipitator, Novel Aerosol Collection, Concentrated samples

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