

Electrochemical Wand

Portable electrochemical wand captures single aerosols at droplet-air interface for atmospheric and health studies.

Many studies have demonstrated the unique properties of chemical reactions on the nanoscale, creating a subfield of electrochemistry dedicated to analyzing the behavior of individual, aerosolized droplets. However, the study of these tiny droplets has up to now been limited. Electrochemistry relies on the use of dual electrodes, which are generally too large for use on the micro scale. Microelectrodes have been utilized to overcome this barrier, but current microelectrodes rely on the droplets being suspended in an oil interface, which limits their applications in real world chemistry since most of these reactions naturally occur in air.

To meet this growing need, researchers at Purdue University have developed a novel electrochemical wand capable of analyzing the physicochemical properties of single liquid aerosols in a droplet-air interface. Their device relies on specially manufactured ultramicroelectrodes, each only approximately 650 nm in radius. These incredibly small electrodes can be positioned so close together in the wand that aerosol particles as small as 20 microns in diameter are capable of spanning the distance between them. This represents a groundbreaking contribution to the study of electrochemical analysis on the particle level in the critical droplet-air interface. In addition to its unique sensing capabilities, this electrochemical wand is also portable and relatively durable, making it suitable for bench research as well as potential field use. With this device, researchers and organizations interested in particle level liquid chemistry will be able to capture and analyze aerosol particles of unprecedented small size. Such capabilities could have far-reaching implications in the fields of air quality, climate, and public health studies as well as basic research.

Technology Validation:

Miniaturized, dual-barrel ultramicroelectrodes (each electrode ~650 nm radius) were fabricated. By targeting a nebulized solution at the electrode surface, aerosols ~20 microns in diameter contacting the micron-sized electrode surface were resolved as discrete, stochastic events when

Technology ID

2023-DICK-70123

Category

Energy & Power Systems/Energy
Storage
Biotechnology & Life
Sciences/Analytical & Diagnostic
Instrumentation

Authors

Jeffrey Dick
Philip James Kauffmann

Further information

Aaron Taggart
adtaggart@prf.org

View online



measuring current as a function of time. Cyclic voltammetry with the dual-barrel electrode in 300 mM hexacyanoferrate showed the expected sigmoidal shape, regardless of which barrel was the working electrode and which was the reference/counter electrode.

Advantages:

- More portable than alternative devices
- Allows analysis of particles as small as 20 microns in diameter
- Does not require particle-into-liquid conversion sampling
- Durable design suitable for potential field deployment
- Single aerosol sensitivity

Applications:

- Identification and quantification of single liquid aerosols, in the lab and potentially in the field
- Atmospheric and climate analysis
- Analysis of liquid aerosols in lab experiments

Public health studies concerned with contents of liquid aerosols in the atmosphere

Publication: Kauffmann, P.; Dick, J. Single Liquid Aerosol Nano-impact Electrochemistry: Accessing the Droplet | Air Interface. Environ Sci Nano. 2023, 10, 1744-1748.

TRL: 5

Intellectual Property:

Provisional-Gov. Funding, 2023-03-16, United States

Utility-Gov. Funding, 2024-03-15, United States

Keywords: Chemical Analysis, Chemistry, Chemistry and Chemical Analysis, droplet analysis, electrochemical analysis, electrochemical wand, liquid aerosol analysis, liquid aerosols, single liquid aerosols