*GEO/ENG nanoscience "Nano highlight"*

# NanoEarth and Environmental Engineering

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***Award:*** Quantification of the pH of Aerosol Droplets via Nanoprobe Based Sensing (ENG/CBET – 1705653)

***NNCI*:** The Virginia Tech National Center for Earth and Environmental Nanotechnology Infrastructure
ENG/ECCS & GEO/EAR – 1542100

Nanoparticle based sensors provide the capacity for in situ detection of analytes within confined spaces that are inaccessible to existing sensor platforms. For instance, nanoparticle sensors have enabled detailed examination within cells as well as organisms at unparalleled resolution. In our recent work, we extended the range of confined systems being probed and utilized gold nanoparticles along with surface enhanced Raman spectroscopy (SERS) to provide the first description of pH within micron-scale water droplets. In droplets, and other aquatic environments, pH is arguably the key parameter dictating many chemical and biological processes. Historically, it has been experimentally challenging to measure the pH of individual droplets due to their inaccessibility to conventional pH probes. Using SERS, we acquired the pH distribution inside droplets and found that a stable pH gradient exists and that the pH in the core of a droplet is higher than that of bulk solution by up to 3.6 pH units. This finding suggests the accumulation of protons at the air/water interface and is thus consistent with recent thermodynamic model results.

**Publication:**

- Haoran Wei, Eric P. Vejerano, Weinan Leng, Qishen Huang, Marjorie R.Willner, Linsey C. Marr, Peter J. Vikesland (2018) Aerosol microdroplets exhibit a stable pH gradient. *PNAS*, DOI:10.1073/pnas.1720488115.

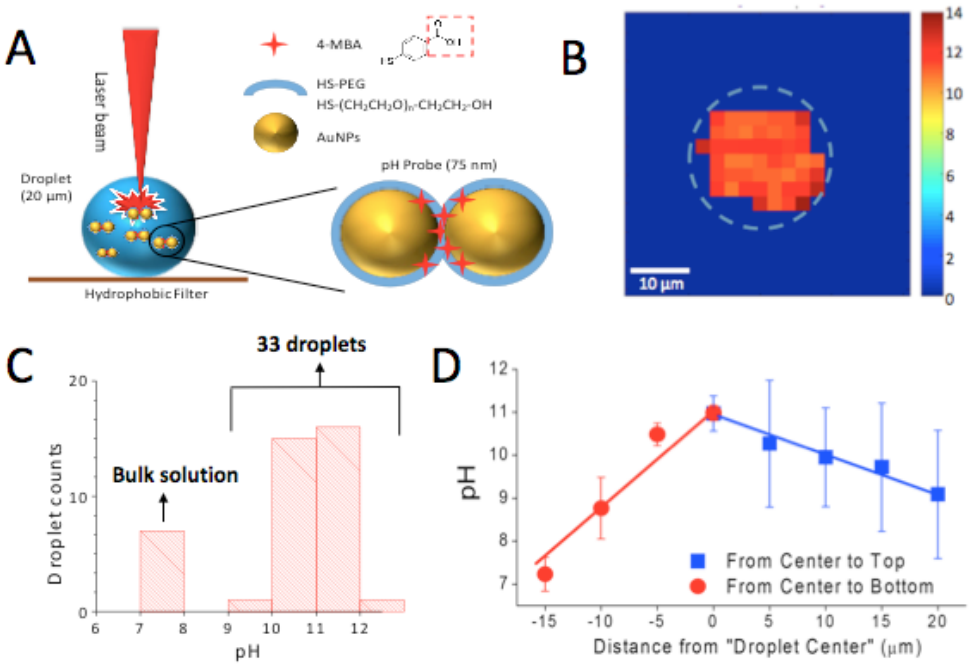


*Figure caption*: A) Schematics illustrating SERS interrogation of droplets collected on a superhydrophobic polyvinylidene difluoride filter and of SERS pH nanoprobes. B) pH map (with color scale indicated) across the center of a ≈20 µm droplet. The dotted line illustrates the physical droplet XY dimensions. No SERS signal was detectable at the droplet edge due to the partitioning of the nanoprobes to the droplet interior. C) pH at the centroid of 33 different droplets

that were produced from bulk solutions with a pH of 7.4. D) The variation in the measured pH value as one moves either up or down in Z from the center of a droplet.