Charged Droplets | Hot Paper

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Solid-to-Liquid Charge Transfer for Generating Droplets with Tunable Charge

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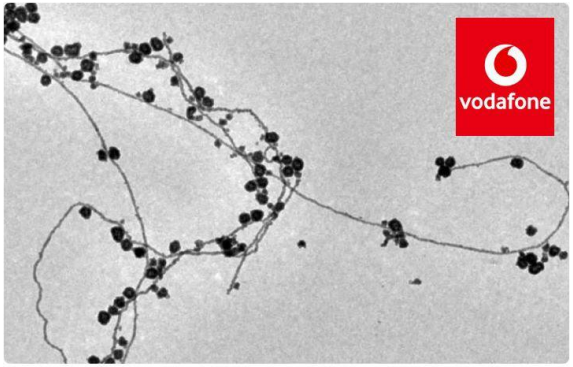
Relevance to lab

1. Electrospray Ionization
2. Drinking water bottles
3. Biology
4. Microfluidic reactors
5. Scrubbers for removing particulates in an air stream



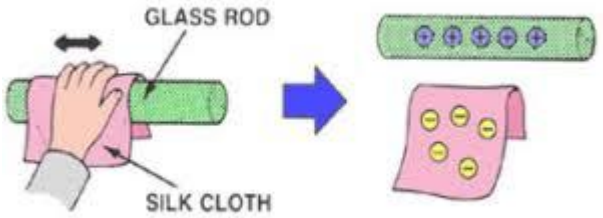
Scientists accidentally create gold nanoparticles in water

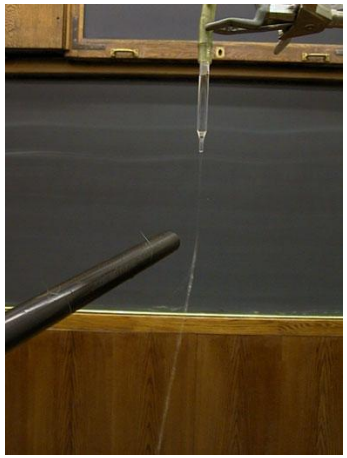
Stanford scientists have accidentally discovered a new way of creating gold nanoparticles and nanowires using water droplets. Gold particles are usually created using gold-containing chloroauric acid and sodium borohydride, a reducing agent. However, when the scientists replaced the reducing agent with water microdroplets, they were surprised to see the reaction still yielded gold nanoparticles.

short by Gaurav Shroff / 20 Apr, 2018

Introduction

1. Contact electrification involves bringing two materials in contact and separating to generate static charge.





A jet of water with charged plastic rod

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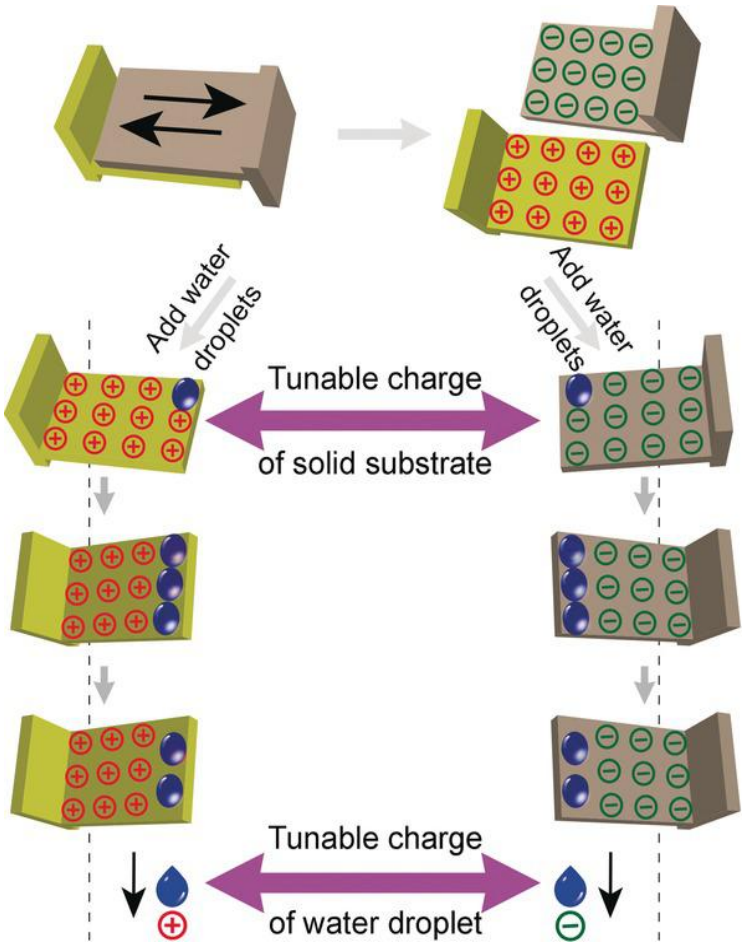
1. Solid surfaces are triboelectrically charged.
2. charge transferred from a solid surface charged by contact electrification to water droplet by rolling it across the statically solid surface.
3. Tuning the static charge on solid surface to vary droplet charge.
4. Finally, using the charged droplets for application like manipulating, coalescing, and sorting the water droplets by solid surfaces charged by contact electrification.

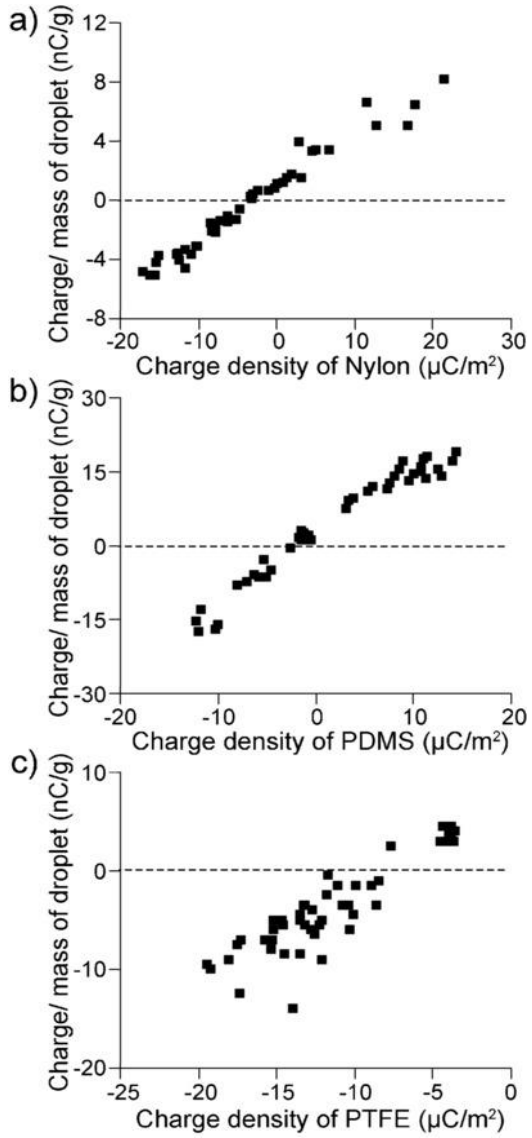
Experimental procedure

1. Nylon(2×2×0.3(cm)) rubbed against PTFE to make it positive charged.
2. Charge on the nylon was measured using a Faraday cup connected to an electrometer.
3. A droplet of de-ionized water (0.1 ml) was slide down the surface under gravity.
4. The droplet was then dropped into the Faraday Cup for measuring its charge.
5. Similarly, Nylon charged negatively by rubbing it against a piece of PEGDA charges droplet negatively.
6. Pressure between 2kPa to 20kPa was applied to vary the surface charge.

PTFE Poly tetra fluro ethylene
PEGDA Poly ethylene glycol diacrylate

Results


Add water droplets
Add water droplets
Tunable charge
of solid substrate
Tunable charge
of water droplet


a)
Charge/ mass of droplet (nC/g)
Charge density of Nylon (μC/m²)
b)
Charge/ mass of droplet (nC/g)
Charge density of PDMS (μC/m²)
c)
Charge/ mass of droplet (nC/g)
Charge density of PTFE (μC/m²)

Analyzing the Charged Water

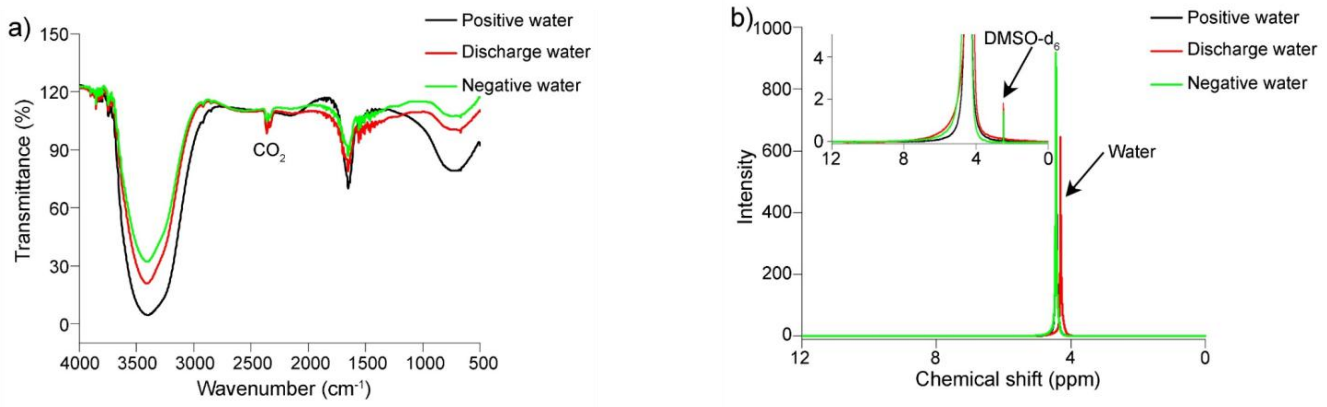
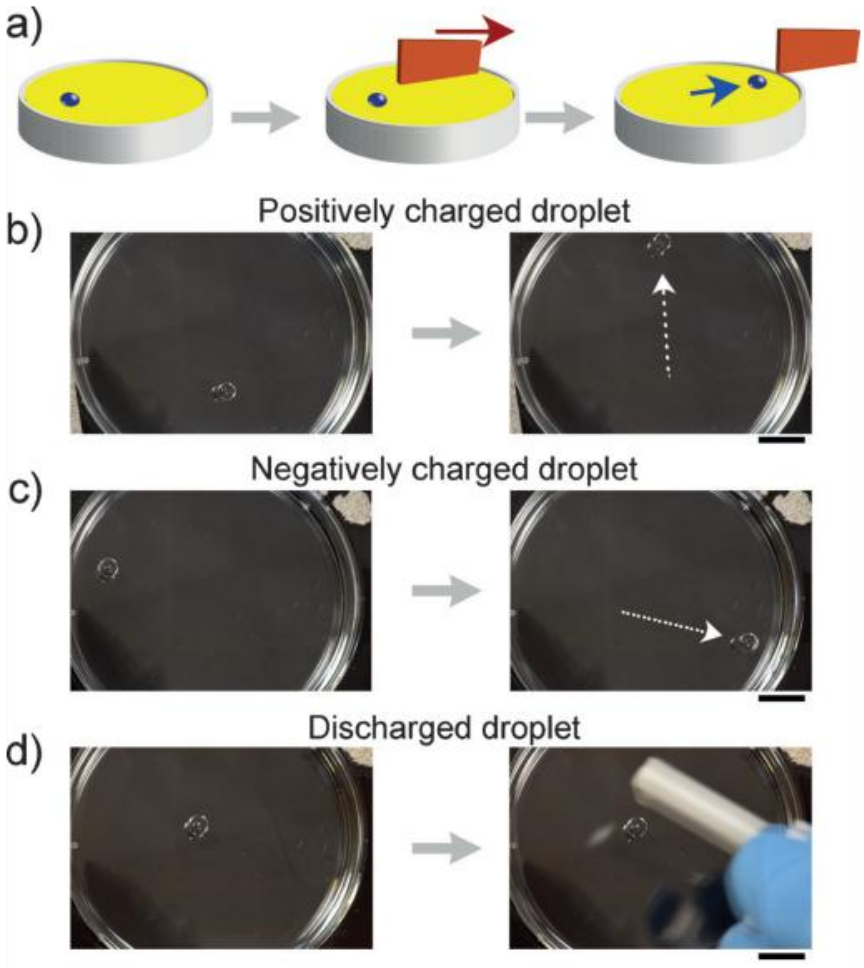


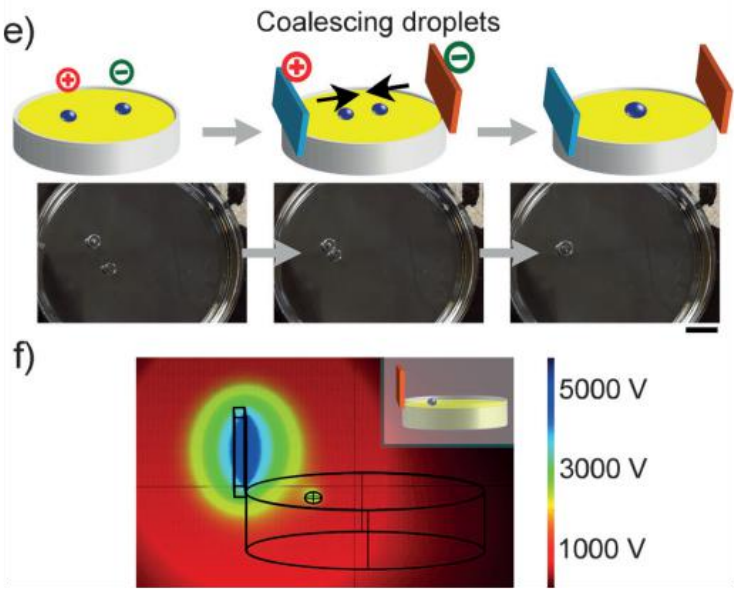
Figure S2. FTIR and 1H NMR spectra of different types of water. (a) FTIR (b) 1H NMR in DMSO-d6. The positively and negatively charged water was charged by flowing across a charged nylon surface.

➞ Results show that the three types of water look similar; hence, at least at the limit of detection of these Instrument, the charged water looks pure.

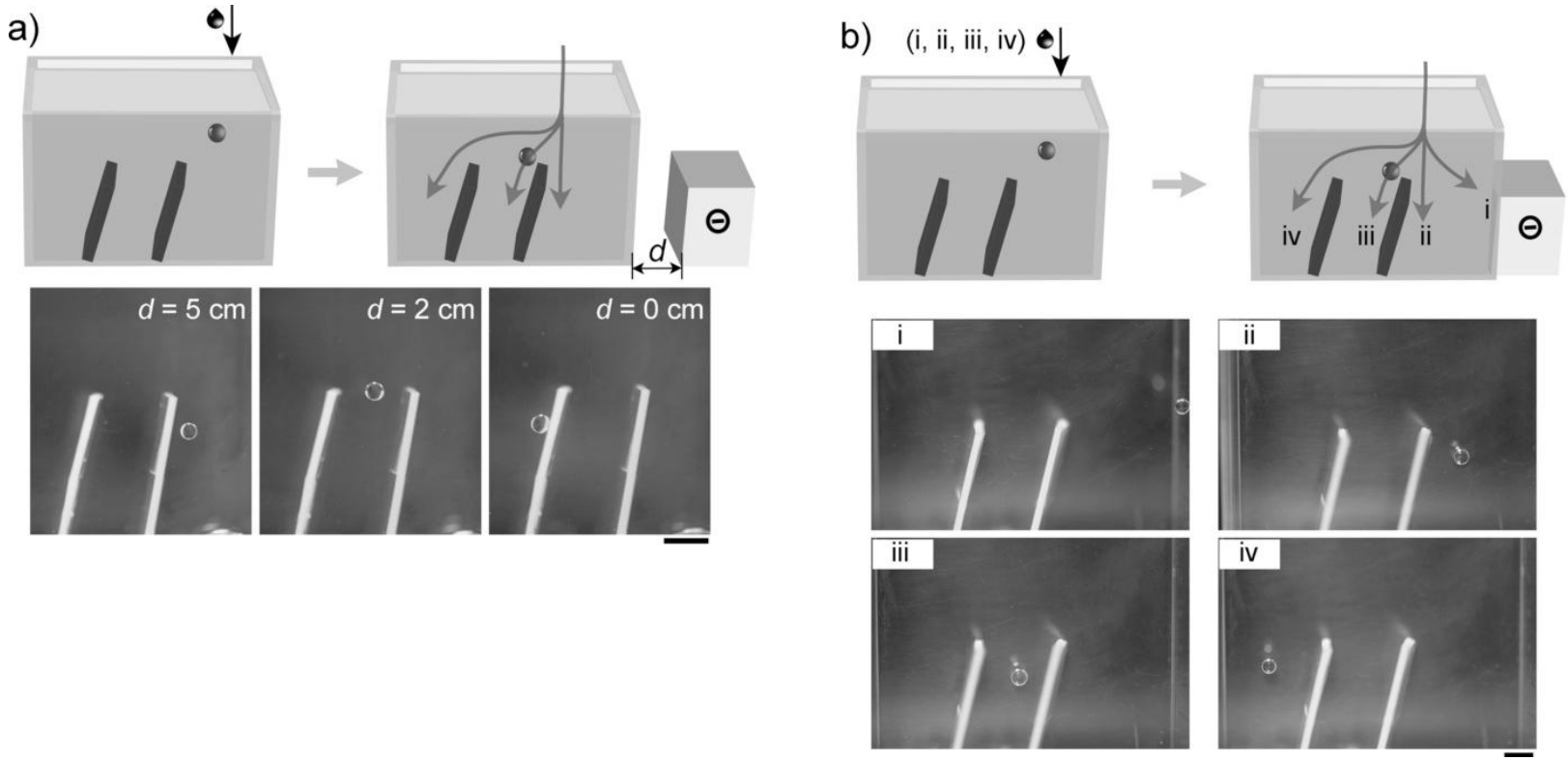
Application: Manipulation



1. A water droplet (0.03 ml) positively by flowing it across an initially uncharged perfluoroalkoxy (PFA) tube.
2. The droplet was placed on the air-liquid interface of a Petri dish filled with silicone oil, and
3. Manipulated with negatively charged PTFE and positively charged nylon rod.

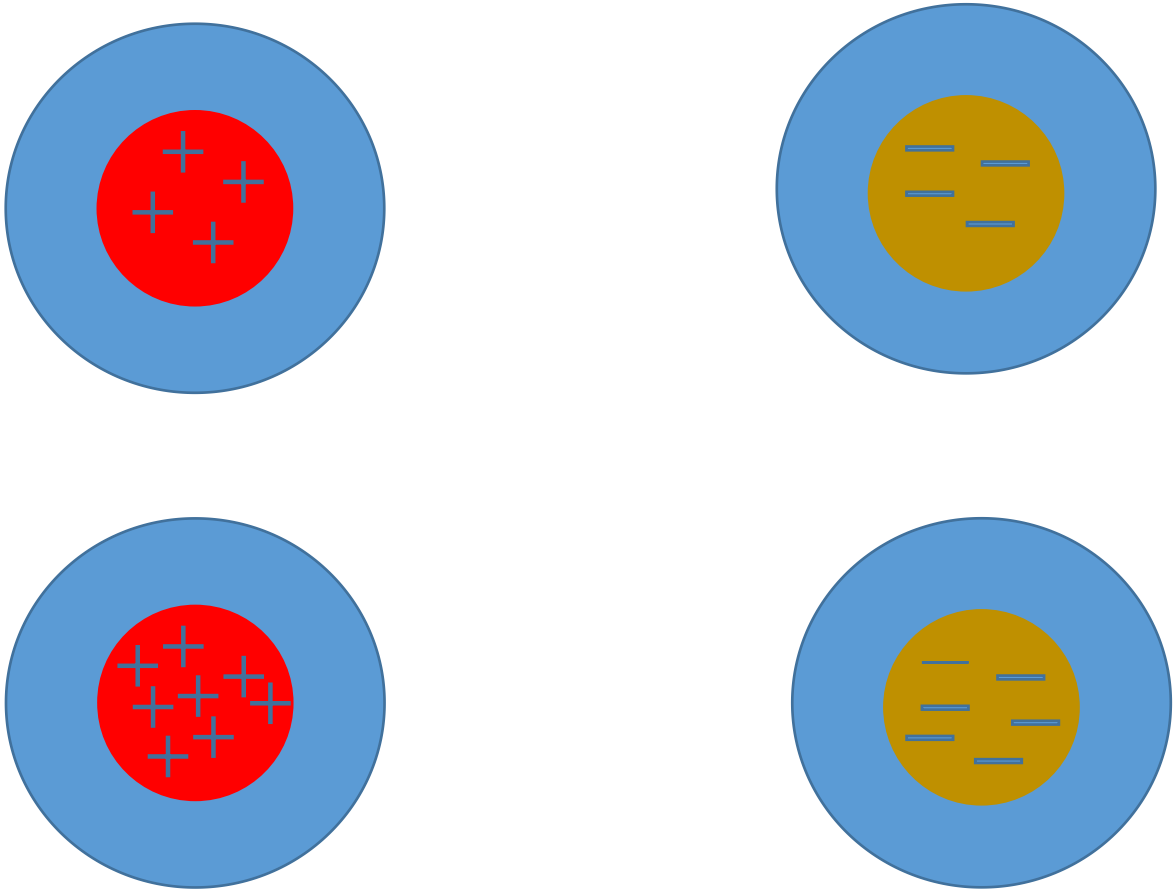


Application: Sorting



Charged water droplet was dropped into a container filled with paraffin oil.

Future plan



Thank you