Contribution ID: **17** Type: **Oral**

ELECTROWETTING ON DIELECTRIC (EWOD) OF SESSILE MICRODROPLETS CONTAINING POLYDISPERSE GOLD NANOPARTICLES

Tuesday 29 November 2016 13:45 (15 minutes)

The wetting property of materials continues to be studied due to its important applications in many natural and industrial processes. Applying an external voltage affects the contact angle and offers a way to manipulate wettability without changing the chemical composition of the contacting phases. The use of external electric fields to control wettability has promising new applications in microfluidics which include laboratory-on-a-chip platforms for various biological sample preparation and analysis processes, fluid lens systems, electrowetting displays, and control of fluids in multichannel structures. Among various droplet manipulating mechanisms, electrowetting-on-dielectric (EWOD) is widely used because of its relatively simple device structure and fabrication. In this study, we investigate enhanced wetting effects of metal nanoparticles at very low concentrations in fluids in an electrowetting on dielectric (EWOD) experiment.

Nanoparticles manifest completely different properties (physical, chemical, electronic, magnetic and optical) from their bulk material. We explore the interaction of gold nanoparticle (AuNP) suspensions in a liquid droplet with applied electric field which cannot be observed with bulk gold. A basic planar electrowetting set-up is employed consisting of a bottom copper electrode coated with a thin insulating layer of uncured PDMS (Silicon oil) mounted on an adjustable stage and a platinum wire upper electrode injected in contact with the sessile electrowetting gold nanofluid microdroplet sitting over the dielectric layer. A voltage source is connected across the top and bottom electrodes and changes in the contact angle of the droplet, as voltage is varied, is captured using a USB microscope camera. The contact angles of the images are determined using a free software Image J.

We first tested our experimental set up with pure fluid (deionized water) microdroplets as the reference fluid. We found the uncured PDMS (Silicon oil) dielectric layer to have high hydrophobicity where the sessile water droplet is observed to have an average initial contact angle of 102.6 degrees (no applied voltage). As voltage is applied at increasing increments of 1 volt, we observe electrowetting actuation (decrease in contact angle). The data for electrowetting of the reference fluid fits well with the Young-Lippmann equation for EWOD with an effective dielectric constant of about 18 and a saturation or breakdown voltage of 35V corresponding to decrease in contact angle to 67.2 degrees. Very low concentrations of gold nanofluid (deionized water containing gold nanoparticles with an average size of 10 nm) were prepared with the following concentrations (μM) : 0.5, 0.25 and 0.05. Following the same procedure with the reference fluid microdroplets, we found that the presence of nanoparticles enhanced the electrowetting actuation of the sessile microdroplets in the described EWOD configuration. All concentrations containing gold nanoparticles showed enhanced electrowetting response (greater decrease in contact angle as voltage is increased) compared to the reference fluid (deionized water). The higher concentration, the more sensitive the electrowetting response. The 0.5 μM gold nanofluid concentration showed sensitivity to very low applied voltage (0-10V) with voltage breakdown (Vx) at 10V corresponding to a saturation contact angle (θx) of 68 degrees and a corresponding effective dielectric constant of 160. The 0.25 μM gold nanofluid concentration showed voltage breakdown Vx =20V, θx = 64.5 degrees and k = 50 while for the 0.05μM gold nanofluid concentration, Vx =30V, θx = 59.5 degrees and k = 30.

Finally, to further verify that the gold nanoparticles are really the reason for the enhanced electrowetting actuation in the microdroplets, an ultra low concentration (0.005 μM) of the gold nanofluid is prepared. The ultra low gold nanoparticle concentration showed identical response to the electrowetting of the reference fluid verifying our claim of the enhanced electrowetting effect due to the gold nanoparticles. These results with sessile microdroplets in EWOD may pave the way to introducing metal nanoparticles towards better and more sensitive microdroplet for electronic and optical manipulation and other applications.

Author: Prof. PATACSIL, Crismar (University of the Philippines Baguio and Ateneo de Manila University (Philippines))

Presenter: Prof. PATACSIL, Crismar (University of the Philippines Baguio and Ateneo de Manila University (Philippines))

Session Classification: Heron 1

Track Classification: Other related topics