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Mechanism for the Enhanced Electrowetting Actuation of Gold Nanofluids

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Electrowetting experiment is done with varying concentrations (in µM) of gold nanofluid (deionized water containing polydisperse gold nanoparticles with an average size of 10 nm): 0.5, 0.33, 0.25, 0.05, 0.01, 0.005 and deionized water (no gold nanoparticle, control fluid). The result showed different electrowetting response for the different concentrations. To explain the mechanism for the observed enhanced electrowetting actuation, the specific capacitance, C, is calculated from the voltage versus contact angle graph for each concentrations. For the control fluid, the calculated specific capacitance is 0.0012 F/m2. The 0.5µM gold nanofluid concentration showed a corresponding C=0.0097 F/m2; the 0.33µM gold nanofluid concentration with C = 0.0049 F/m2 ; the 0.25µM gold nanofluid concentration with C = 0.0027 F/m2 and the 0.05µM gold nanofluid concentration, with C = 0.0015 F/m2. The 0.005µM and the 0.001µM gold nanofluid concentrations both have electrowetting behavior identical to the control fluid. The values imply that the presence of gold nanoparticles electrically affects electrowetting by specifically increasing the capacitance with increasing concentration of the nanoparticles. This increase in specific capacitance can only be explained if we see that the gold nanoparticles as collectively acting like a non-polar dielectric medium between the electrodes. When voltage is applied between the electrodes, charges may build up at the gold nanoparticle surfaces and are polarized. Polarized gold nanoparticles will line up with the applied potential and create an induced potential opposite this applied external potential resulting in the increase of the capacitance. Additional induced charges are built up at the interface (at the bottom of droplet) due to the polarized gold nanoparticles in addition to the induced charges from the water dielectric medium. The droplet flattens (decrease in contact angle) due to electromechanical force at the triple line interface. The greater the applied voltage, the more additional induced charges due to the contribution of the polarized gold nanoparticles are accumulated at the interface (bottom of droplet) and thus the greater the electomechanical force. This capacitance and electromechanical model may explain this electrowetting phenomena involving gold nanofluid droplets.

Biography

Crismar Patacsil completed his MS in Physics at University of Philippines Diliman, Quezon in 2004 and is currently a PhD student at Ateneo de Manila University under Dr. Rapahel Guerrero as his dissertation adviser. Currently, he is an Assistant Professor in Department of Physical Sciences, College of Science at University of Philippines Baguio, Baguio City.

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