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Dielectric Study of Ethanol Water Mixtures at Different Concentration Using Hollow Channel Cantilever Platform

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Abstract : Understanding liquid properties in small scale has become important in recent decades as immerging new microelectromechanical systems (MEMS) devices have been widely used for micro pumps, drug delivery, and many other laboratory-on-microchips analysis. Often in microfluidic devices, fluids are transported electrokinetically. Therefore, extensive knowledge of fluid flow, heat transport, electrokinetics and electrochemistry are key to successful lab on a chip design. Among different microfluidic devices, recently developed hollow channel cantilever offers an ideal platform to study different fluid properties simultaneously without drastic decrease in quality factor which normally occurs when traditional cantilevers operate in the liquid phase. Using hollow channel cantilever, we monitor changes in density and viscosity of liquid while simultaneously investigating dielectric properties of alcohol water binary mixtures. Considerable research has been conducted on alcohol-water mixtures since such a mixture is a typical prototype for biomolecules, Micelle formation, and structural stability of proteins (to name a few). Here we show that hollow channel cantilever can be employed to investigate dielectric properties of ethanol/water mixtures in different concentrations. We study dynamic amplitude shifts of hollow channel cantilever oscillation at different concentrations of ethanol/water for different voltages. Our results show how interactions between solute and solvent, and possibly cluster formation, could change dielectric properties and dipole reorientation of the mixture, as well as the resulting force on the hollow cantilever. For comparison, we also examine higher conductivity ionic mixtures of sodium sulfate solution under the same conditions as low conductivity ethanol/water mixtures. We will show the results from systematic investigation of solvent effects on dielectric properties of the binary mixture. We will also address the question of resolution limits in dielectric study of analyte molecules imposed by solvent concentrations.

Keywords : dielectric constant, cantilever sensors, ethanol water mixtures, low frequency
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