DNA Analysis Chip by Electrowetting Actuation

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The aim of this project is to fabricate a massively parallel genomic DNA analysis system in chip-based format. The considered DNA sequencing technique is Pyrosequencing; a method of real-time sequencing by synthesis. In this technique, each of the four nucleotides is added stepwise triggering the release of light (through the use of coupled enzymatic reactions involving firefly Luciferase). The light signal is then detected by a photo detector. We are proposing to use individual electronic control of droplets for transport and mixing, using the principle of electrowetting on dielectrics. In this technique, electrodes are covered by a dielectric layer (silicon nitride or oxide) and then coated by a hydrophobic material (Teflon). Contact angle of the droplet sitting on top of the dielectric-coated electrode is reduced considerably when voltage is applied to the electrode, resulting in a more hydrophilic surface. As a result, the droplet is forced to move on the hydrophobic surface toward the electrode to which voltage has been applied. This enables two-dimensional addressing of the droplet on the surface. We believe that combining the flexibility and simplicity of electrowetting droplet actuation along with advantages of Pyrosequencing provides a powerful platform for DNA analysis. We have fabricated a few chips to examine the possibility of performing Pyrosequencing-based DNA analysis in microliter and submicroliter-sized wells. Furthermore, we have been fabricating sets of chips to experiment principles of electrowetting-on-dielectric actuation. A sample electrowetting chip is shown in the figure.