

Fabrication of a Chip-Based Electrowetting Unit

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We report on the enhancement and optimization of the micro-fabrication of an *Electrowetting-on-Dielectric* (EWOD) chip, based on the technique of *Grounding-from-Below*. This chip is to be integrated into a table-top electrowetting unit that can be easily transported to other labs and institutions for demonstration and use. Electrowetting is a microfluidic technique that controls the motion of a droplet of liquid sitting on a hydrophobic surface by applying an electric field to the droplet to change its surface energy. This results in a decrease of the droplet's contact angle, creating a *wetting* effect in which the droplet spreads over the hydrophobic surface. EWOD chips with *Grounding-from-Below* micro-fabrication are susceptible to dielectric breakdown due to the high voltage and small dielectric thickness requirements. Dielectric breakdown can occur in the Parylene C layer, the polymer coating that is used to insulate the electrode and ground lines. On average, the KGI in-house micro-fabricated chips required 70 V DC at $\leq 50 \mu\text{A}$ for a $0.8 \mu\text{m}$ Parylene layer, and 150 V DC at $\leq 50 \mu\text{A}$ for a $1.6 \mu\text{m}$ layer. Dielectric breakdown was observed as either large spikes in current ($\approx 2 \text{ mA}$) or electrolysis (bubbling of the drop). Due to dielectric breakdown problems, our focus evolved to improving the quality of the Parylene layer in order to minimize current leakage and increase the durability of ground lines. The CVD parameters were optimized to control the thickness and purity of the Parylene C layer. Decreasing the chamber vacuum from 35 mmHg to 15 mmHg, and increasing the thickness of Parylene from $0.8 \mu\text{m}$ to $1.6 \mu\text{m}$ slowed the onset of dielectric breakdown. The placement of ground lines for mitigating dielectric breakdown was also investigated. The adhesion of the ground lines to Parylene surface was improved by reducing the concentration of the etchant and the duration of etching.

