LONG-TERM RELIABLE CONTACTLESS BIO-FLUIDS DELIVERY WITH CLOG-FREE MICROFLUIDIC EJECTOR USING LIQUID-FILM-EMBEDDED VALVE

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ABSTRACT

Quick evaporation speed of microfluids can cause many unexpected problems and failures in various microfluidic devices and systems. In this dissertation, a new evaporation speed controlling method is demonstrated using a thin liquid-film based microfluidic valve. Microfluidic droplet ejectors were designed, fabricated and integrated with the liquid-film based microfluidic valve. The thin liquid film with non-volatility and immiscibility exhibited excellent microfluidic valve functionality without any stiction problem between valve components, and provided a very effective evaporation protection barrier for the microfluids in the device. Successful evaporation control by the liquid-film-embedded (LiFE) microfluidic valve has been demonstrated. In addition, guided actuation of the microfluidic valve along predefined paths was successfully achieved using newly developed oil-repellent surfaces, which were later used for developing 'virtual walls' for confining low surface tension liquids within predefined areas. Moreover, bio-inspired slippery surfaces for aiding the microfluidic valve along the ejector surface have also been developed. These slippery surfaces were evaluated for their effectiveness in reducing microfluidic valve driving voltages. Finally, a sliding liquid drop (SLID) shutter technique has been developed for a normally-closed functionality with aid from nanostructures. The SLID shutter resolves many issues found in the previous LiFE microfluidic valve. Smooth and successful printing results of highly volatile bio-fluids have been demonstrated using the SLID shutter technique. I envision that these demonstrated techniques and developed tools have immense potential in various microfluidic applications.