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Building on Previous Microvalving Approaches for Highly Reliable Actuation in Centrifugal Microfluidic Platforms

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Abstract : With the ever-increasing myriad of applications of which microfluidic devices are capable, reliable fluidic actuation development has remained fundamental to the success of these microfluidic platforms. There are a number of approaches which can be taken in order to integrate liquid actuation on microfluidic platforms, which can usually be split into two primary categories; active microvalves and passive microvalves. Active microvalves are microfluidic valves which require a physical parameter change by external, or separate interaction, for actuation to occur. Passive microvalves are microfluidic valves which don't require external interaction for actuation due to the valve's natural physical parameters, which can be overcome through sample interaction. The purpose of this paper is to illustrate how further improvements to past microvalve solutions can largely enhance systematic reliability and performance, with both novel active and passive microvalves demonstrated. Covered within this scope will be two alternative and novel microvalve solutions for centrifugal microfluidic platforms; a revamped pneumatic-dissolvable film active microvalve (PAM) strategy and a spray-on Sol-Gel based hydrophobic passive microvalve (HPM) approach. Both the PAM and the HPM mechanisms were demonstrated on a centrifugal microfluidic platform consisting of alternating layers of 1.5 mm poly(methyl methacrylate) (PMMA) (for reagent storage) sheets and ~150 µm pressure sensitive adhesive (PSA) (for microchannel fabrication) sheets. The PAM approach differs from previous SOLUBON™ dissolvable film methods by introducing a more reliable and predictable liquid delivery mechanism to microvalve site, thus significantly reducing premature activation. This approach has also shown excellent synchronicity when performed in a multiplexed form. The HPM method utilises a new spray-on and low curing temperature (70°C) sol-gel material. The resultant double layer coating comprises a PMMA adherent sol-gel as the bottom layer and an ultra hydrophobic silica nano-particles (SNPs) film as the top layer. The optimal coating was integrated to microfluidic channels with varying cross-sectional area for assessing microvalve burst frequencies consistency. It is hoped that these microvalving solutions, which can be easily added to centrifugal microfluidic platforms, will significantly improve automation reliability.

Keywords : centrifugal microfluidics, hydrophobic microvalves, lab-on-a-disc, pneumatic microvalves
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