Serial-siphon based flow control on centrifugal lab-on-a-disc platforms

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One of the crucial steps in biological analysis systems is the spatio-temporally controllable release of a repertoire of assay reagents. Microfluidic siphons comprise attractive structures in centrifugal platforms as they can be utilized for several functions, such as valving, pumping, metering and mixing. Moreover, centrifugal forces have been shown to positively benefit active flow-through assays, especially for surface-based assays, by decreasing total assay time and increasing assay sensitivity.

In this work, we implement rotational flow control on a polymeric microfluidic "lab-on-a-disc" device by combining serial siphoning and capillary valving for sequential release of on-board stored liquid reagents. The functionality of this integrated, multi-step centrifugal assay platform is tightly linked by the capability to establish reproducible, capillary-driven priming of the innately hydrophobic siphon microchannels made from common poly(methyl methacrylate) (PMMA) substrates. We propose the deposition of hydrophilic polymeric thin films onto PMMA discs by spin coating, in order to increase the hydrophilicity of the substrates. The main advantages of the method include quick formation of uniform coating, stability and low-complexity / low-cost equipment. A surface-based immunoassay for monitoring human immunoglobulin G in a bioprocess workflow has successfully demonstrated using the proposed centrifugal platform.