Fabrication of out-of-plane microvalves for whole blood separation on Lab-on-a-CD

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The emergence of Lab-on-a-CD (compact disc) technology provides a centrifugal and compact platform for high throughput blood analysis in point-of-care (POC) diagnostics. Blood separation of the whole blood is the first step for clinical blood diagnosis. This work describes a novel design of an out-of-plane microvalve that enables high performance of the whole blood separation on Lab-on-a-CD centrifugal devices.

In our Lab-on-a-CD design, the centrifugal force due to CD rotation was used as driving force for blood pumping. Blood cells and plasma were redistributed into a downstream sedimentation reservoir and an upstream supernatant reservoir, respectively, when the CD spins. The microchannels with microvalves were built by casting Polydimethysiloxane (PDMS) on bilayer photoresist molds (Fig. a and b). By tuning the rotational speed, the "close" or "open" status of the out-of-plane microvalve embedded in the Lab-on-a-CD device (Fig. c) was controlled to isolate these two reservoirs. Compared with the similar design but without the out-of-plane microvalve, this novel microvalve structure can effectively prevent blood cells from diffusing back to the supernatant reservoir containing pure plasma, and thus improve the performance of blood separation as well as subsequent blood analysis (Fig. d and e). We have demonstrated that the Lab-on-a-CD device with the out-of-plane microvalves can achieve 99.9% plasma purity and 96 ± 0.5% plasma yield for the whole blood. Because of its simple structure and easy-controlled working mechanism, the out-of-plane microvalve not only leads high performance of whole blood separation, but also causes the manufacturing of this type of Lab-on-a-CD devices easy and low-cost.

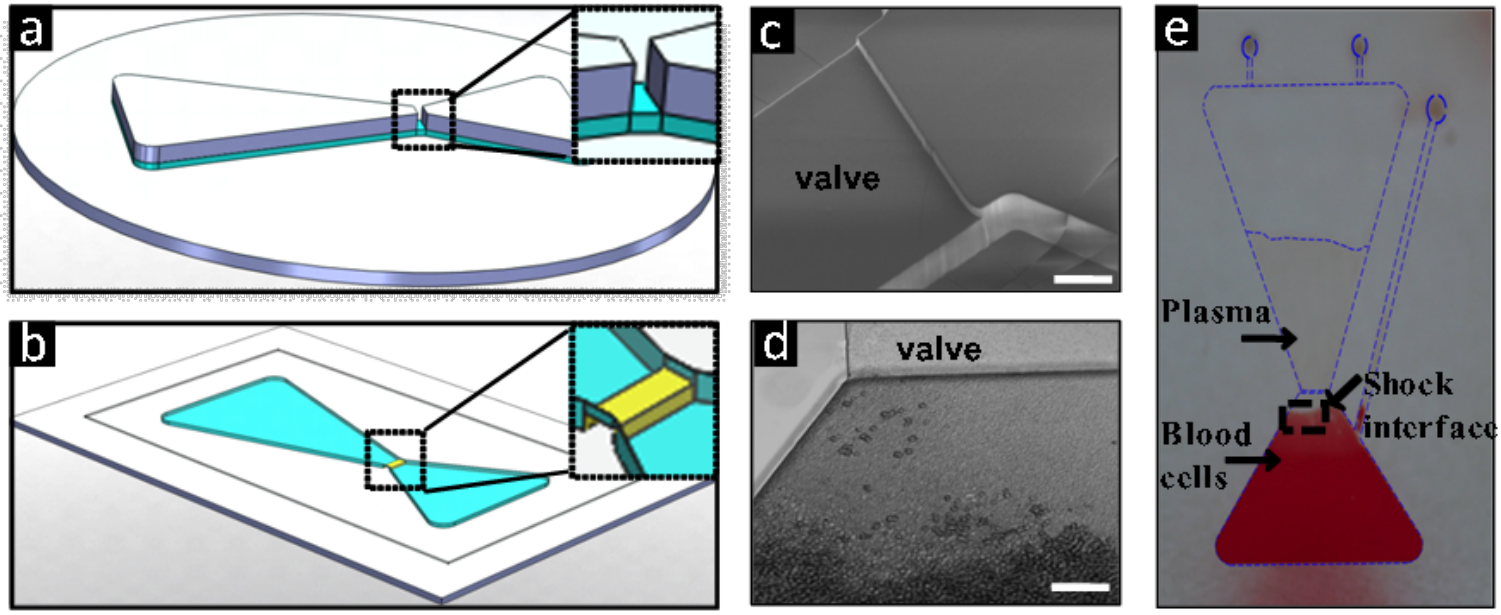

Figure (a) Schematics of the aligned bilayer photoresist mold for the out-of-plane microvalve and (b) a PDMS replicate fabricated out of the mold. (c) SEM image taken at the out-of-plane microvalve. (d, e) Performance of microvalve for blood separation.

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