Supplementary Information for:

Real-Time Monitoring and Actuation of a Hybrid Siphon Valve for Hematocrit-Independent Plasma Separation from Whole Blood

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Figure S1: Types of passive Valves in centrifugal microfluidic discs

Figure S1a-c illustrates the most used passive valves in centrifugal microfluidic discs to regulate fluid flow during various process steps, including capillary valves, hydrophobic valves, and siphon valves. These valves function based on the interplay between centrifugal force and other passive forces such as surface tension. For example, the capillary valve (**Figure S1a**) remains closed until the centrifugal force exceeds the capillary force. The hydrophobic valve involves sudden narrowing of a hydrophobic microchannel or coating of fluorinated polymers on the channel surface to enhance its hydrophobicity and prevent liquid flow (**Figure S1b**). The siphon valve relies on capillary priming of liquid in an S-shaped hydrophilic microchannel (**Figure S1c**). To actuate the valve, the rotational speed must be reduced to decrease centrifugal pressure until the capillary pressure overcomes it. At this point, the capillary force propels the liquid meniscus to pass the crest point and prime the valve. Unlike other passive valves, the siphon valve is closed at a higher speed than the critical velocity.

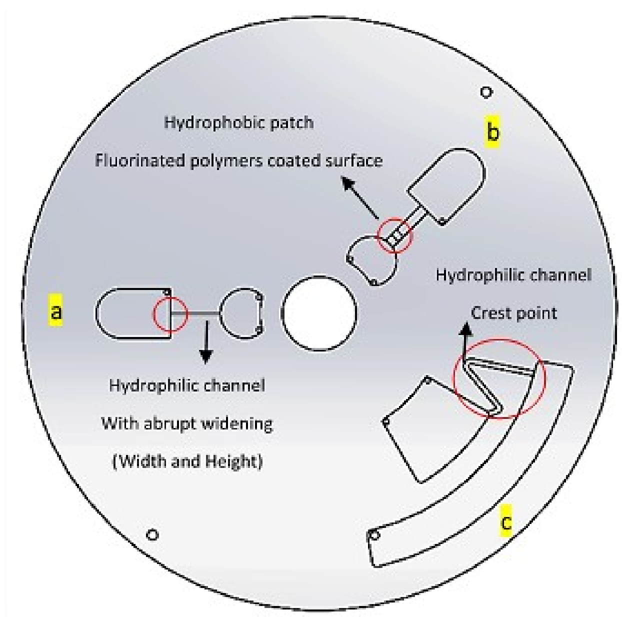

Figure S2: Designed and manufactured disc for evaluating effect of parameters on siphon valve performance

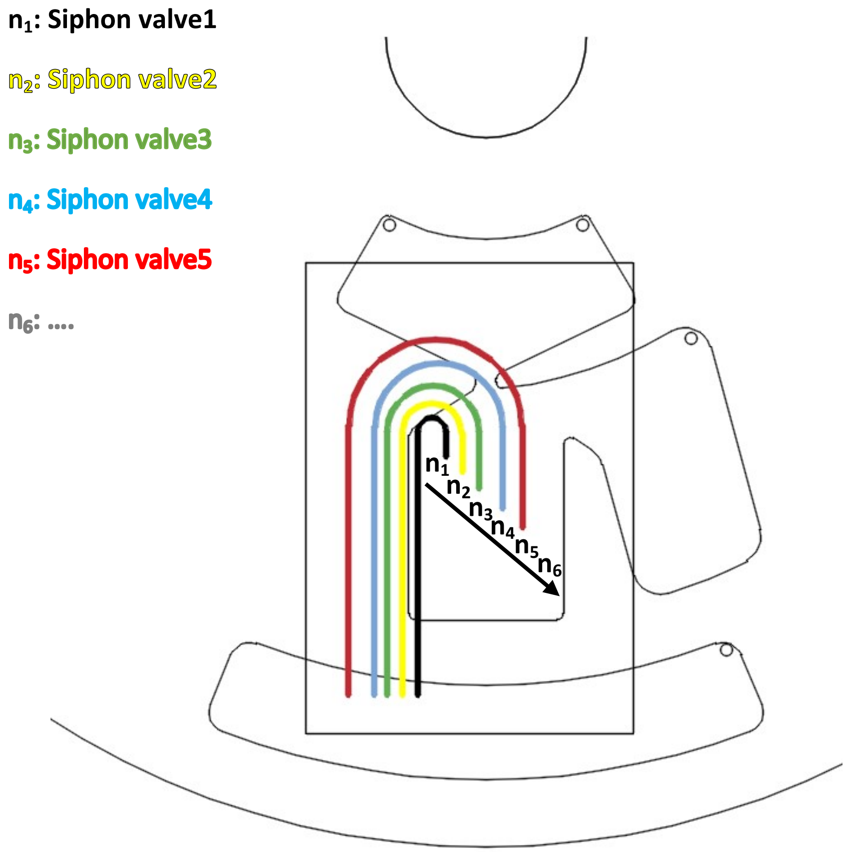

Figure S3: Designed and manufactured disc for evaluating effect of parameters on siphon valve performance

To validate **Equation 6**, we designed various models of siphon valves including main chamber with a depth of 1mm, a siphon microchannel, and a secondary chamber with a depth of 1.5 mm. The microchannel had a width of 1mm and a height of 0.1 mm.

We designed a siphon valve with R_0= 22.8mm and R_C = 19.8mm to investigate how the contact angle and fluid viscosity affect the valve's performance. To explore the effect of R_0 and R_C on the valve's performance, we varied these parameters between 21.3 to 25.8 mm and 16.8 to 22.5 mm, respectively, while holding all other parameters constant.

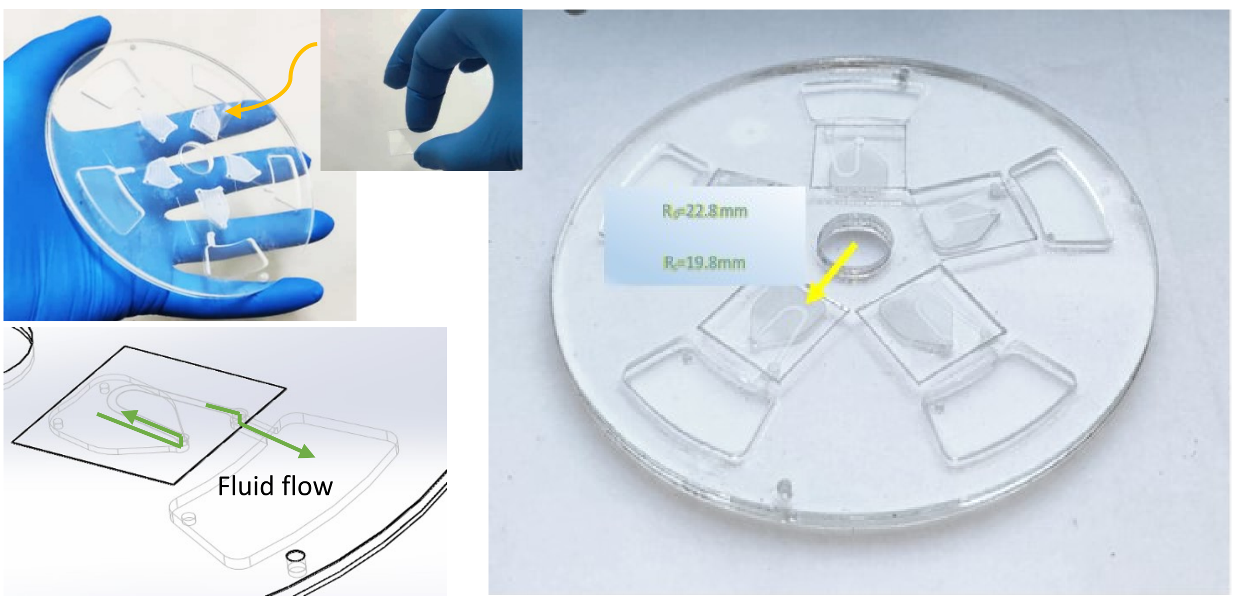

Figure S4: Fabrication techniques

There are two methods for manufacturing the discs. The first method, laser cutting, involves using seven layers (**Figure S3a**). This approach avoids tool marks and reduces fabrication time. The second method, which uses CNC machining and is shown in **Figure S3b**, involves five layers. This method increases the accuracy and precision of fabrication, reduces the weight of the disc, and lowers material costs.

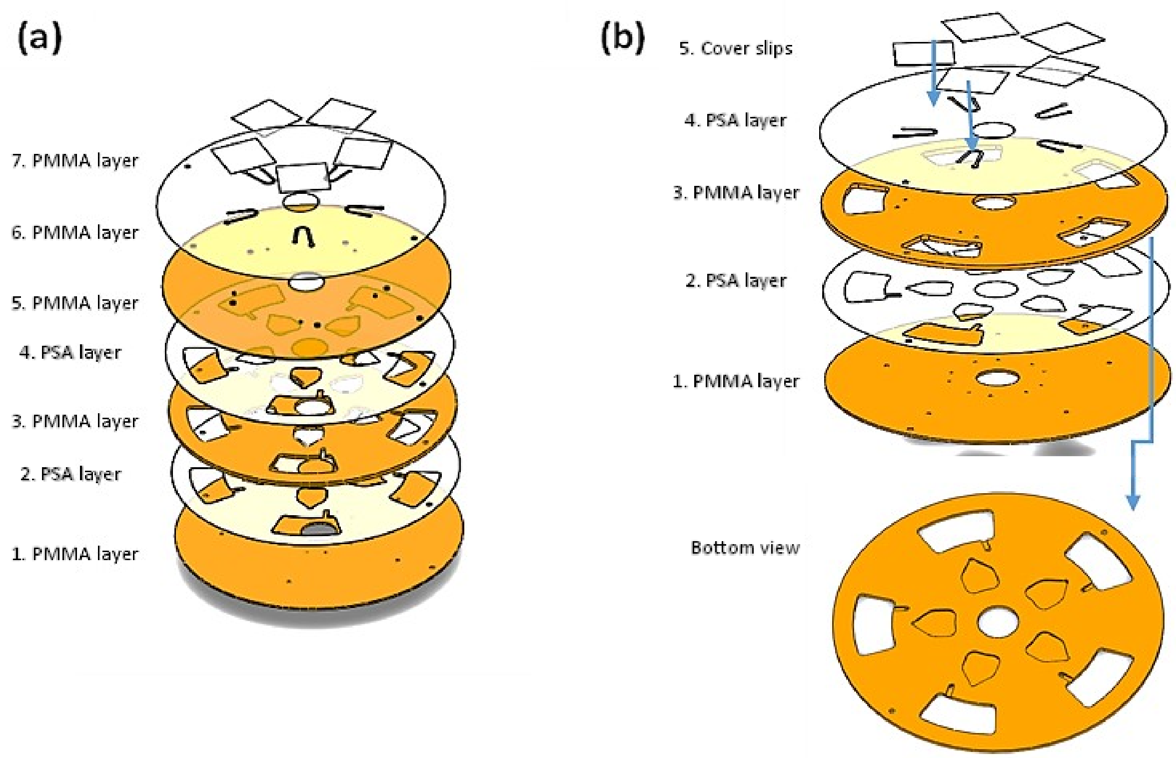

Figure S5: Experimental Setup

A custom-built centrifugal platform, specifically the CD Imager K1000 from Key Lead Solutions Inc in San Francisco, CA, USA, was employed for real-time monitoring of fluid motion. The platform featured a servomotor (1) with a velocity range of 50 to 8000 rpm and a resolution of 1 rpm, as well as a strobe light, low exposure time, and high-quality Zeiss camera (2) for capturing fluid dynamics. By connecting the centrifugal disc to the servomotor's shaft (3), a velocity-time profile could be applied using dedicated software. The resulting fluid motion within the disc was then evaluated and observed on the screen (4) to analyze its behavior and dynamics.