Electronic Supplementary Material (ESI) for Lab on a Chip.

A Novel Manual Rotating Fluid Control Mechanism in a Microfluidic Device with a Finger-Actuated Pump for Dual-Mode Sweat Sampling

Calculations were performed using the Young-Laplace equation for rectangular channels below:

$$BP = -2\sigma\left(\frac{Cos\ \theta_I^*}{b} + \frac{Cos\ \theta_A}{h}\right)$$

σ = Surface tension of the liquid.

θ_I^* = Modified contact angle, given by min [$\theta_A + \beta, 180°$]

θ_A = Contact angle of the channel surfaces.

β = Diverging angle of the channel.

b = Width of the diverging section.

h = Height of the diverging section.

From our design, we got the Parameters needed in our Calculations

1/ Surface tension (σ)

The surface tension of the liquid is (sweat) a water, in this case is typically around 0.0728 N/m.

2/ the contact angle (θ_A)

The materials used (PLA BASIC), using 0.2mm nozzle for printing affects how fluid interacts with the channel surfaces. The contact angle recovers to about 80°.

3/ Diverging angle of the channel (β)

The CBVs have specific diverging angle CBV =90°

4/ Width and Height of the diverging sections were 0.2mm and 0.5mm respectively

$$BP = -2 \times 0.0728\left(\frac{-1}{0.2\times10^\wedge-3} + \frac{0.1736}{0.5\times10^\wedge-3}\right)$$

Calculate each term inside the parentheses:

$$\frac{-1}{0.0002} \approx -5000\mathrm{N/m}$$

$$\frac{0.1736}{0.0005} \approx 347.2\mathrm{N/m}$$

Combine the Terms

$$[-5000 + 347.2] \approx -4652.8$$

Calculating:

$$\mathrm{BP} \approx 0.0728 \times 2 \times 4652.8 \approx 677.4 \text{ Pa}$$

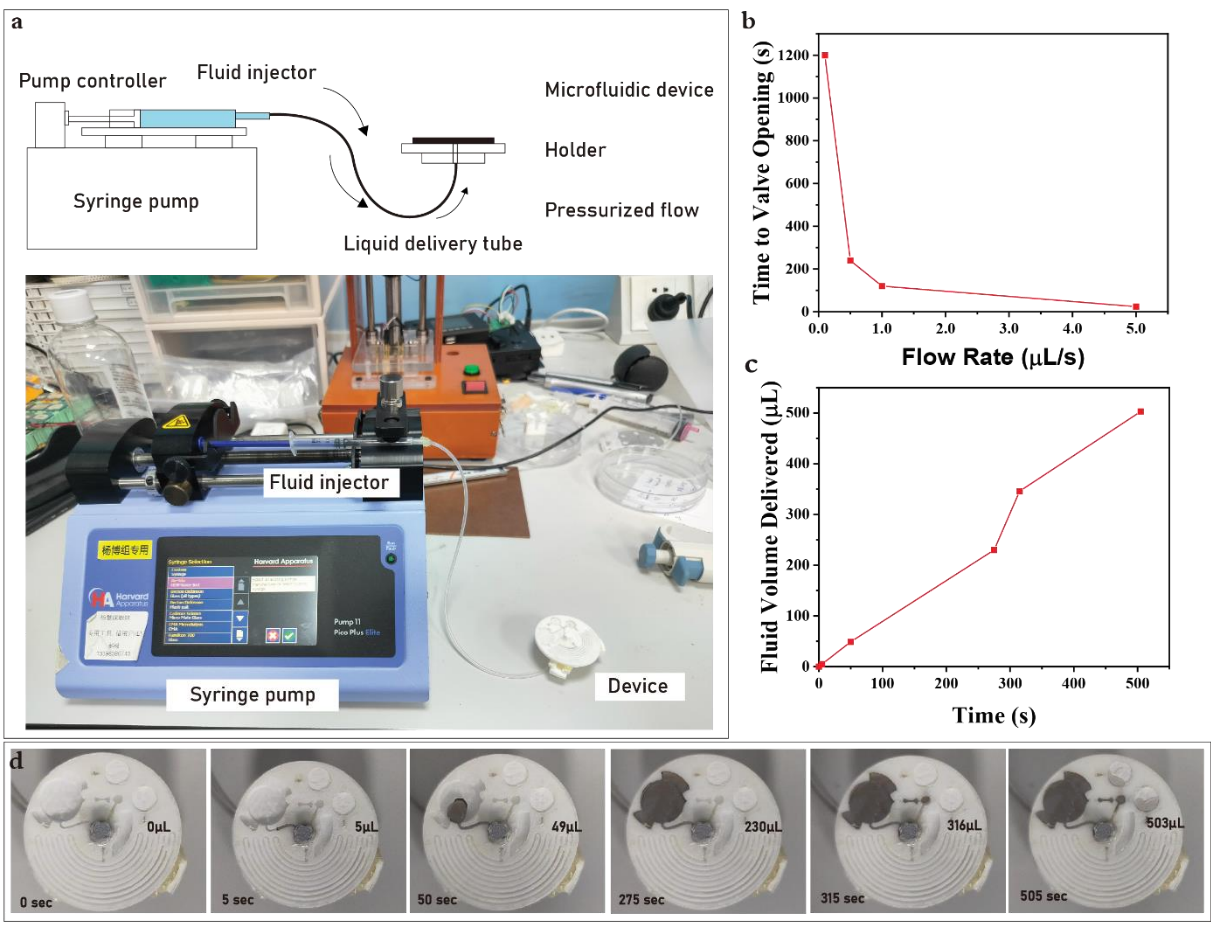

Figure S1. The figure presents a comprehensive overview of the experimental setup and results related to the flow rate and bursting pressure (BP) for the capillary burst valves in the microfluidic device used for fluid delivery. (a) Illustrates the components of the system, including a pump controller, fluid injector, microfluidic device holder, and a pressurized liquid delivery tube, alongside a photograph of the syringe pump in use. (b) depicts a graph showing the relationship between flow rate (μL/s) and the time taken to open the valve, revealing an inverse correlation where increased flow rates result in reduced valve opening times, highlighting the efficiency of the fluid delivery mechanism, (1 μL/s) flow rate has been used for testing. Meanwhile (c) presents a time-dependent graph of fluid volume delivered versus time, demonstrating a linear increase in fluid output as time progresses, which signifies the reliability and predictability of the system's performance over time. Finally, (d) features a series of sequential images capturing the dynamic process of fluid movement within the microfluidic channels at various time intervals (from 5 seconds to 300 seconds), visually illustrating the progression of fluid delivery and providing insight into the operational efficiency of the device in real-time scenarios. Together, these panels convey the effectiveness of the microfluidic system in achieving precise fluid control and delivery.

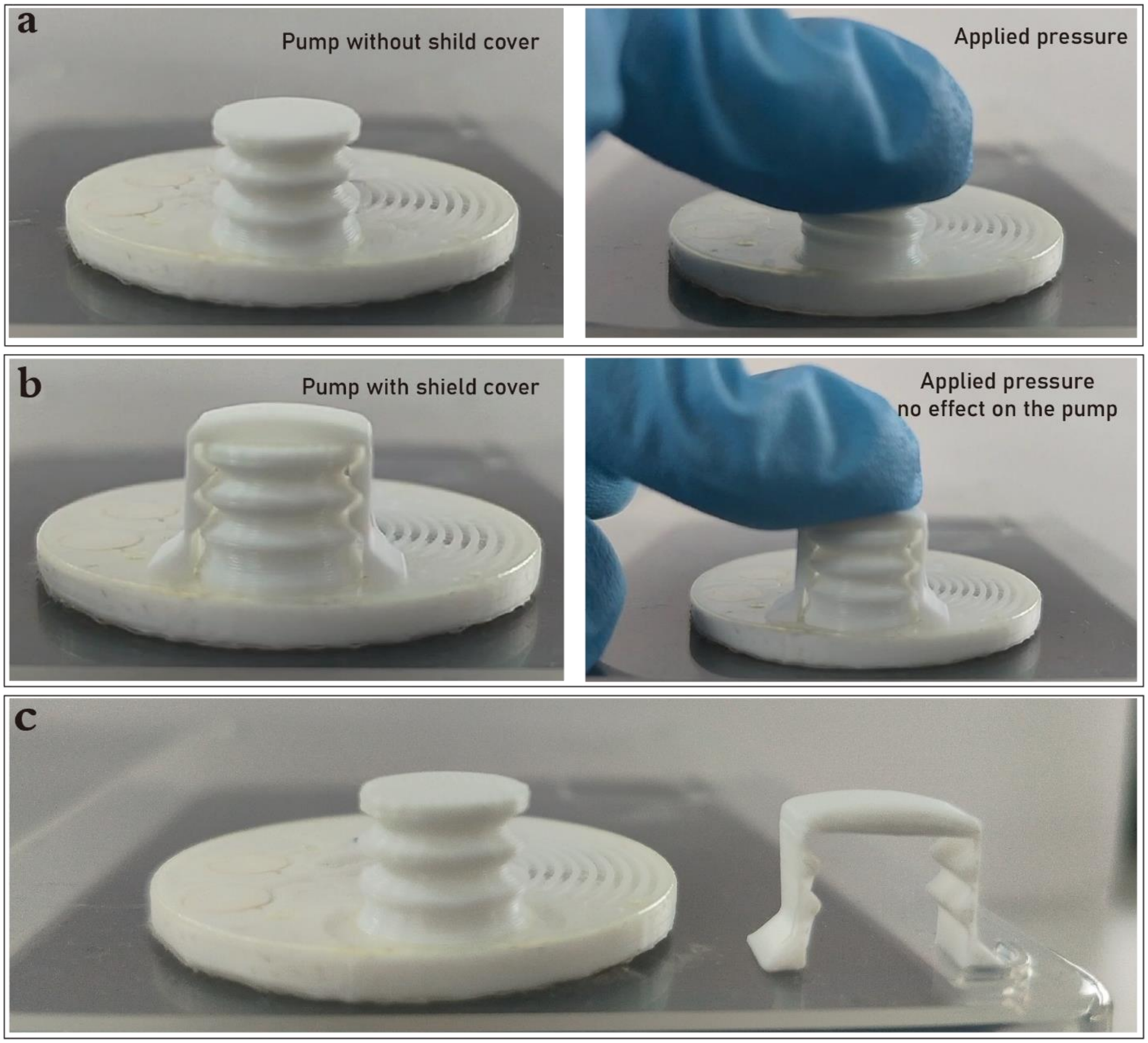

Figure S2. The figure illustrates the design and functionality of a protective shield for the Finger Actuator Pump, help preventing accidental contact during operation. (a) Shows the pump without the shield cover, highlighting its elevated position, which could lead to unintended interactions during physical tests. In the subsequent image of this panel, an applied pressure is demonstrated, showcasing the pump's responsiveness. (b) Presents the pump fitted with the protective shield, emphasizing its role in preventing contact while simultaneously displaying the mechanism's operation under pressure conditions, which ensures safety during use. The second image in this panel further illustrates a user applying pressure to the shielded pump, reinforcing the idea that the design allows for safe manipulation without direct contact with the sensitive actuator. (c) Provides a close-up view of the protective shield, revealing its structure and how it effectively encases the pump while allowing for functional interaction. This thoughtful design not only enhances user safety by minimizing the risk of accidental contact but also maintains the operational integrity of the Finger Actuator Pump during testing and application, ensuring a balance between accessibility and protection.