Patterned Adhesive Enables Construction of Nonplanar Three-Dimensional Paper Microfluidic Circuits†

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Supporting Information

S1 .Effect of adhesive on fluid wicking time in a 1D channel

In order to more fully characterize the effects of different adhesives and stencils on fluid wicking, wicking tests were performed with 2 mm x 20 mm 1D open channels. Channels were tested with both adhesives (3M's 75 and 77) under three application conditions (unpatterned, applied through stencil #1 (23% open), and applied through stencil #5 (63% open)) and compared to an adhesiveless 1D control and to the planar 3D test devices (Figure 2C, Figure 5). Shown below in Figure S1, the wicking times for channels with adhesive applied through stencils #1 and #5 fell between those of the adhesiveless channel and both unpattterned adhesive coated channels. In addition, the wicking times of channels with patterned adhesives were considerably shorter than the wicking times of planar 3D test devices constructed with adhesive applied through the same stencils (Figure 2C, Figure 5). Collectively, these results suggest that the adhesives reduce both lateral wicking and interlayer fluid transfer.

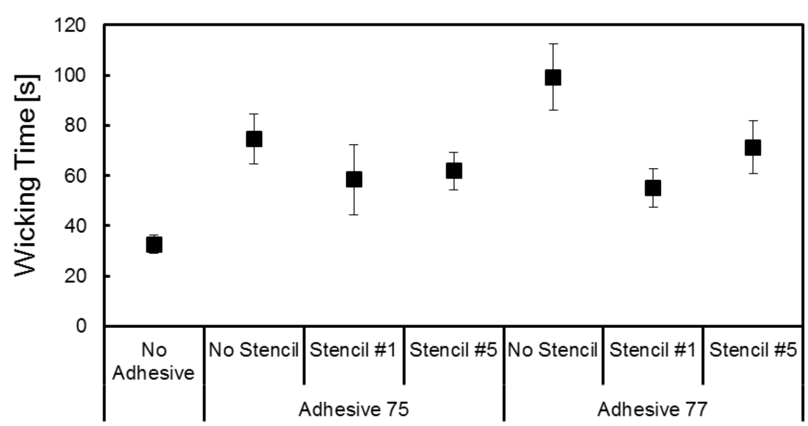

Figure S1 Average wicking times in 2 mm wide, 20 mm long, 1D open channels under different adhesive application patterns. N=10. Error bars represent standard deviation.

S2. Effect of relative humidity during storage on device viability

In order to investigate the effect of ambient humidity on the ability of the adhesive to maintain interlayer contact, 2 mm channel devices were prepared with 3M's 77 adhesive applied through stencil #1. They were then placed in a jar inside a humidity-controlled chamber (Model 5503-11E, Electro-Tech Systems, Glenside, PA) and allowed to come to equilibrium at a specified relative humidity for an hour at room temperature. The jars were then sealed and left to sit for a week, after which the jars were opened and the devices were tested.

As shown in Figure S2, extended contact with humid air severely degrades the adhesive's ability to maintain sufficient interlayer contact for wicking. This result shows that storage of the device under dry inert gas is desirable. If storage under such conditions is not feasible, an alternative adhesive may be preferable.

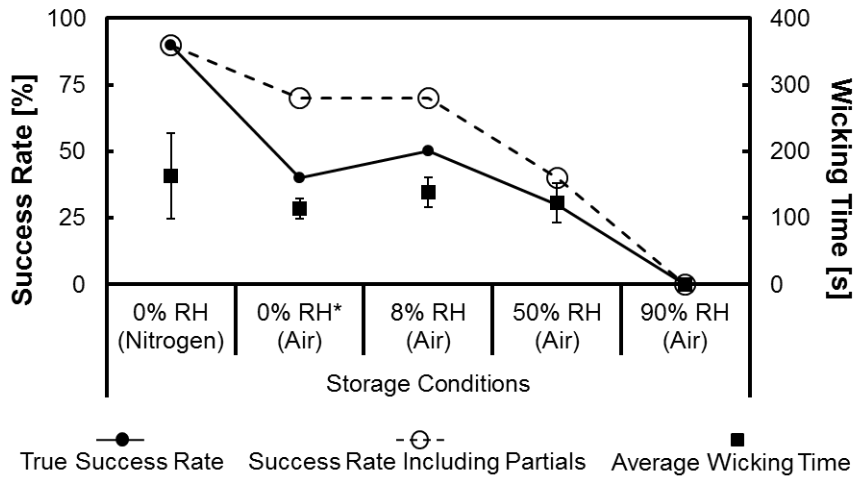

Figure S2 Success rates and average wicking time of 2 mm channel devices after a week of storage under varying relative humidities. N=10. Error bars represent standard deviation. *0% RH (Air) condition is simulated by enclosing 8% RH air in a jar containing desiccant crystals (Drierite, 6 Mesh).

S3. Wicking demonstration in a nonplanar 3D paper microfluidic circuit (origami peacock)

Video S1 Nonplanar 3D paper microfluidic circuit. The origami design is modified from an origami peacock[32]. The core of the circuit is contained inside the body of the origami peacock and is designed to allow three fluids to cross over one another without mixing. Three colored aqueous solutions (red, blue, and yellow) wicked into the body of the peacock before passing into the tail of the peacock without any discernable color mixing. This video file is five seconds long, made from a series of time lapse images, contains 5 frames per second with each interval corresponding to 3 min.