Electronic Supplementary Information for

Paper on a disc: Balancing the capillary-driven flow with a centrifugal force

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Supplementary Information

Effect of pore size on the wicking of water

We also determined the effect of pore size on the flow rate along the rotating paper stip. The temporal change of wicking distance of water in paper strips, of which pore size was 11 μm, on a rotating disc according to the spin speeds is shown in Fig. S1a. Compared to the experimental results with the papers of which pore size is 22.5 μm shown in Fig. 2b, the flow rate became slower (See Fig. S1b). As one can easily predict, the flow rate was higher and wicking distance was larger for the paper with larger pore size due to its higher permeability.[1] This result shows the type—physical properties—of papers also affects on the wicking velocity of water along the rotating paper.

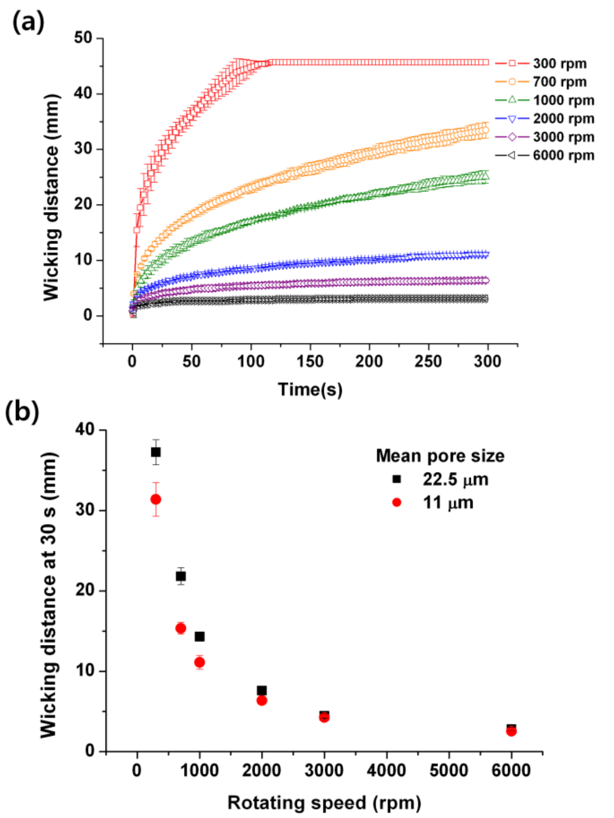

Fig. S1 Effect of pore size on the wicking of water along a rotating paper strip. (a) The wicking distance of water in paper strips, of which pore size was 11 μm, on a rotating disc according to the spin speeds. (b) The wicking distance at 30 s against the rotating speed for filter papers with different pore sizes – 11 and 22.5 μm.

Intensity profile of a paper in the repetitive wicking-draining process

When we drained the water from a wetted paper by rotating the paper on a disc, there was still a little amount of liquid in the area, where has been already wetted once, although most of them drained out by centrifugal force. This might be due to several effects including the capillary penetration of water, diffusion of the water into the interior of the fibers, and adsorption of a surfactant on fibers.[2] To distinguish the 'partially-wetted' area in the paper during the draining step, we measured the intensity of the paper because the whiteness of the paper was slightly changed according to the amount of water it contains as shown in Fig. S2a. The intensity profile of the paper along the radial axis is shown in Fig. S2b. During the wicking step at 1000 rpm, the fluid front moved toward the inside of the disc and the wetted area became darker than the initial intensity of the dried paper, I_0, as time goes by. During the draining step, the position of the interface between the wetted area and the dried area maintained and the intensity of the paper became slightly brighter, but not the same with the initial intensity because of the residual liquids remained in the paper. When the rotating speed was slowed down to 700 rpm, the de-wetted water was absorbed by the paper again, thereby the intensity of the fully-wetted area became the same with that at the previous wicking step.

Wicking of water in square wave

The active control of wicking-draining of water could be precisely conducted as shown in Fig. 4. It was also possible to make the wetted level varies like a square wave as shown in Fig. S3a. Here a repetitive up-and-down spin program was utilized as shown in Fig. S3b. There was no significant influence due to the partially-wetted area of the paper, where a little residual liquid remain, on the wicking distance of water during this repetitive wicking-draining process.

References

1. A.J. Katz and A.H. Thompson, *Phys. Rev. B*, 1986, **34**, 8179-8181.
2. E. Kissa, *Textile Res. J.*, 2010, **66**, 660-668.

Electronic Supplementary Material (ESI) for Lab on a Chip

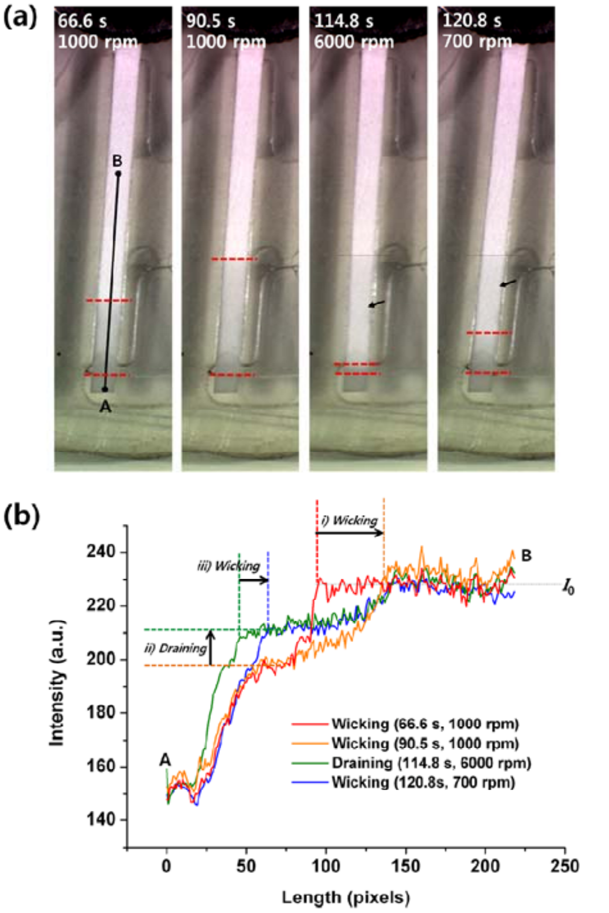

Fig. S2 Intensity change of a paper strip during the repetitive wicking-draining processes. (a) Pictures of a paper during the wicking-draining process. (b) Intensity profile across A–B in (a).

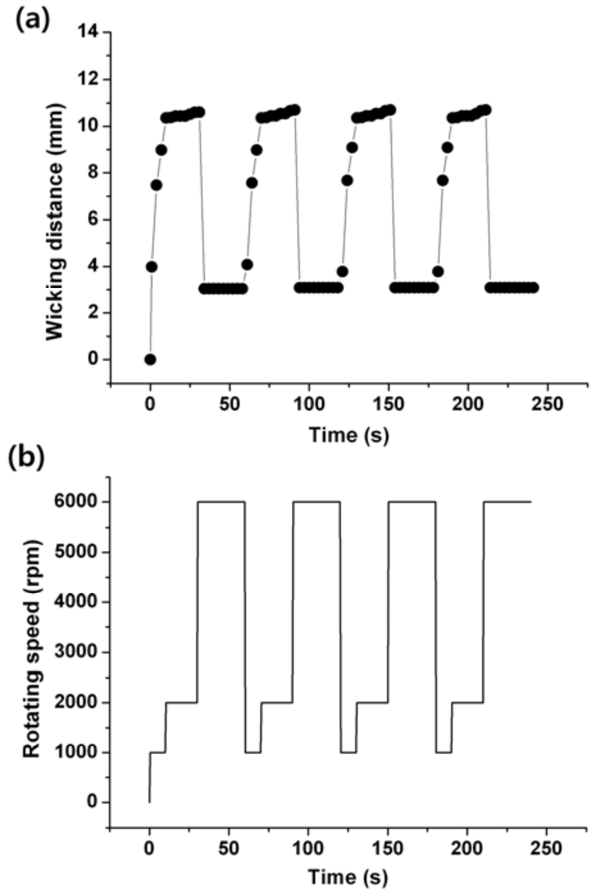

Fig. S3. Repetitive wicking-draining of water on a rotating paper strip. (a) Wicking of water in a square wave form. (b) Spin program for repetitive wicking-draining of water.