Electronic Supplementary Information for Soft Matter Manuscript:

Capillary Instability in Screen-Printed Micropatterns

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Materials and methods

When the squeegee drenched with ink slides over the screen mask, the ink passing through the screen opening was deposited on the substrate anchored on a vacuum table. Not only all SP process parameters such as printing speed, squeegee angle, and snap-off distance affecting the morphology of the printed pattern were maintained, but also the same ink was used in all experiments. The substrates were only adjusted, and the equilibrium contact angle (θ_c) on the substrates was measured to explore the wetting characteristics of the substrate. There should be a difference in wetting behavior between pure solvent and ink; however, to figure out the wetting characteristics of the substrates concerning ink, the contact angles of the solvent (TPN) were measured by varying the substrates. All substrates were seen in partial wetting condition (spreading parameter *S* derived by Young's equation is negative), and the difference between the measured maximum and minimum values of the spreading parameter is about 8 times (Figure S1, Supporting Information).

The merchandised silver paste (LS-450-5, Asahi Chemical Research Lab. Co., Ltd.) for the SP ink is a suspension of particulate silver powder in solvent and resin, to which binder material is put. To enhance the liquidness of the ink, a certain amount of extra solvent (terpineol (TPN)) was added to a commercial paste. Terpineol satisfies the requirements for printing on Polydimethylsiloxane (PDMS) substrate[1], thus obviating the need to consider the penetration of the solvent into the PDMS substrate. The SP ink exhibited shear-thinning, which is a reduction in viscosity as an increasing shear rate (Fig S2a, Supporting Information). Considering that the shear thinning effect becomes gradually substantial with increasing shear rate, it was possible to carefully predict that the viscosity of ink would be much lower than 10 cP at around the general SP operating shear rates ($\sim 10^3 s^{-1}$). Figure S2b is a photograph of SP equipment used for experiments. The screen opening was composed of straight line patterns

designed by varying the line width (opening width w_0) of 30 to 100 μm in increments of 10μm, and the SP direction is parallel to the rectilinear pattern (Fig S2c, Supporting Information). Under all the same conditions, only varying the substrate, the different printing patterns were experimentally observed.

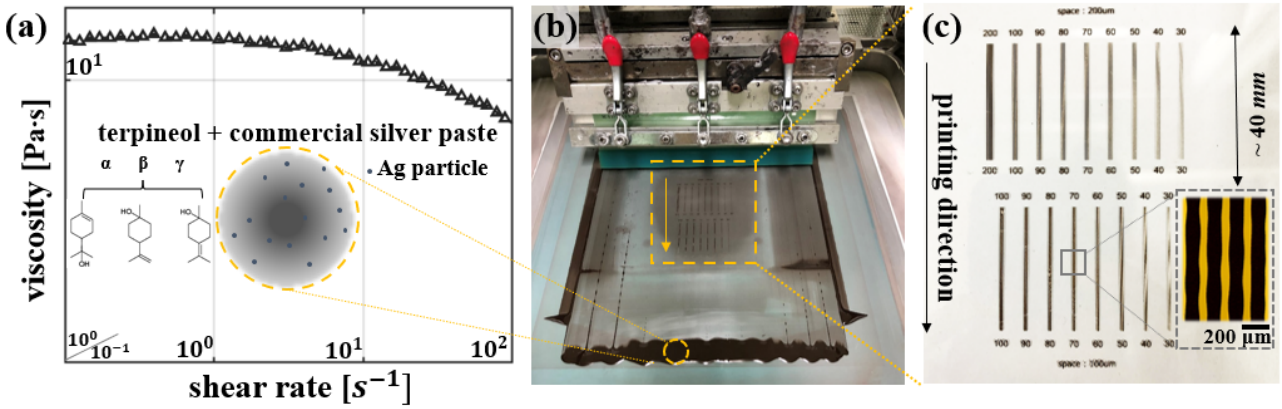

Figure S1. (a) Viscosity measurement of the ink with sweeping of the shear rate. Image of (b) the actual apparatus for the SP and (c) the screen mask used in this study.

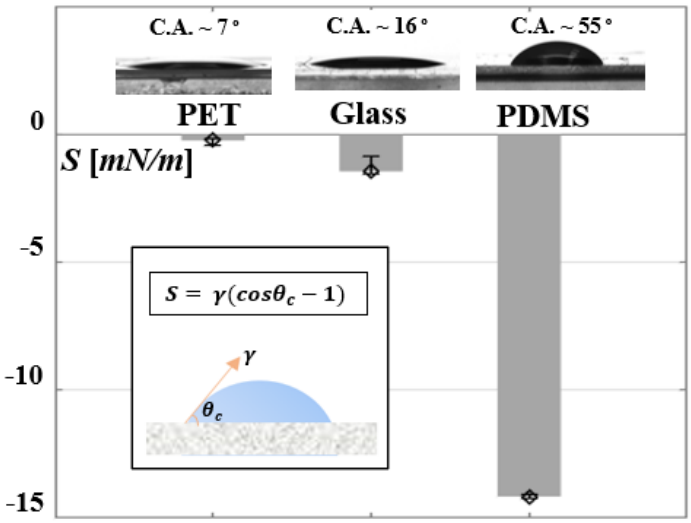

Figure S2. Measurement of equilibrium contact angle (θ_c) and calculation of Spreading parameter (S) of solvent to the PET, Glass, and PDMS substrates.

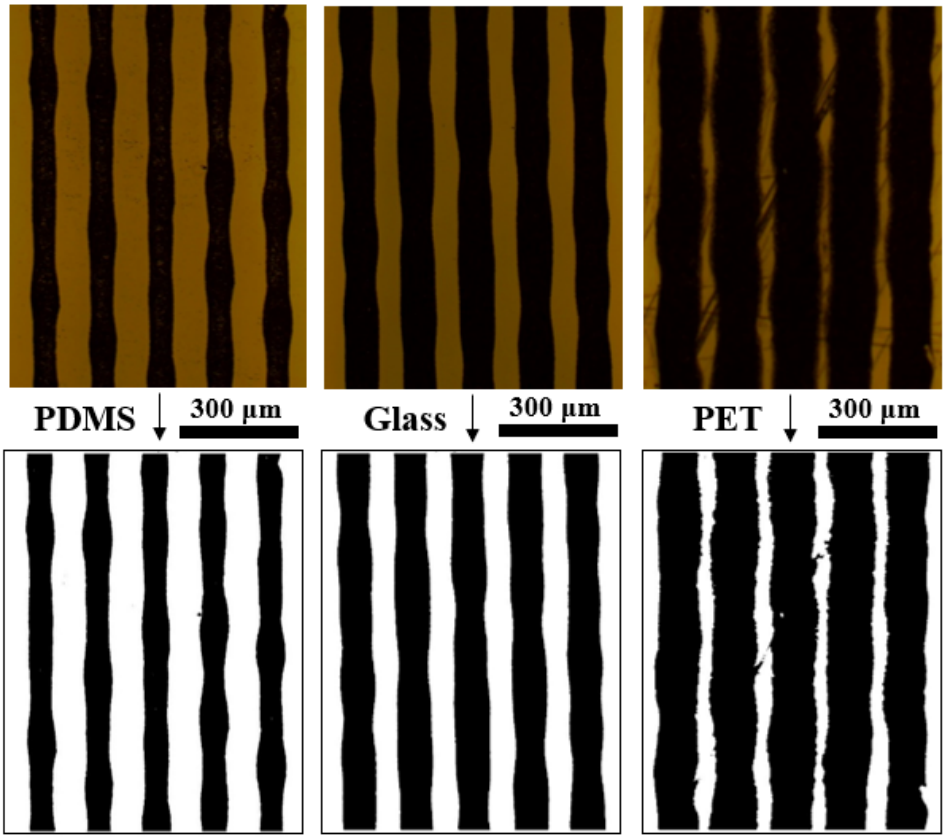

Figure S3. Screen-printed images and binarized images to calculate the actual printed area.

The printed area is calculated by counting foreground pixels.

References

1. I. Kim and S. Chun, J. Electron. Mater., 2011, 40, 1977-1983.