

Electronic Supplementary Information

Electrically robust silver nanowire patterns transferrable onto various substrates

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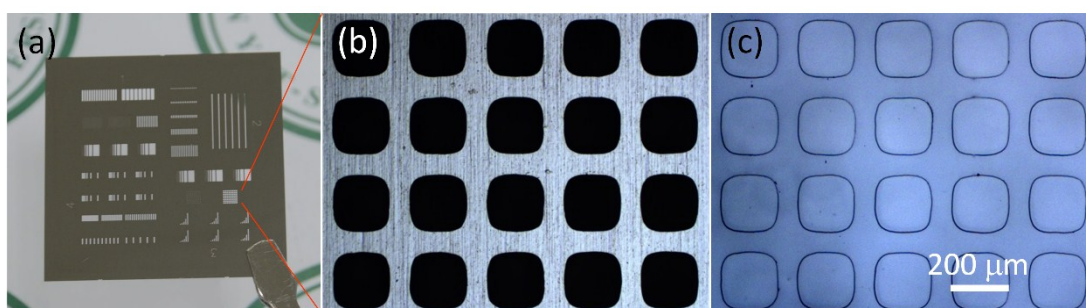


Fig. S1 (a) Photograph of the shadow mask. OM images of (b) the shadow mask and (c) PDMS after the UV/O₃ treatment.

The shadow mask is made of the stainless steel sheet with size of 40*40 mm in which there are micro-patterns fabricated by the photolithography, as shown in Fig. S1 (a). Thanks to the sticky surface of PDMS, the shadow mask is naturally in close contact with the membrane, which prevents the spreading of ozone to unexposed region during the UV/O₃ treatment. So the patterns of the shadow mask can be accurately transferred to the PDMS, as shown in fig. S1 (c). The accurate transfer is conducive to the high fidelity of the patterning process by the wetting/dewetting. Note that this method for patterning substrate with a high wettability contrast (water CA difference up to ~115°) is much simpler than both the photolithography and stamp contact printing.¹

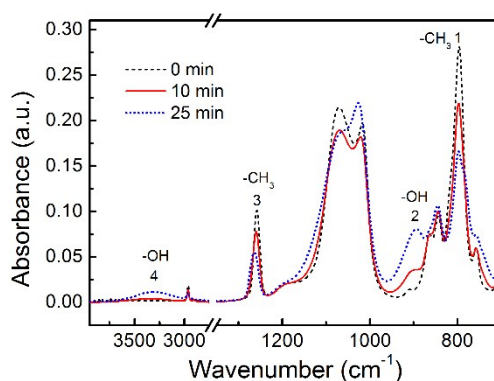


Fig. S2 FTIR-ATR spectrum of the PDMS treated by UV/O₃ for different time. The bands originating from -CH₃

rocking and vibration are located at 798 and 1263 cm^{-1} (bands 1 and 3), respectively. The bands induced by -OH groups are centered at 894 and 3320 cm^{-1} (bands 2 and 4). An obvious decrease of bands 1 and 3 can be observed with increasing of the treating time, which is accompanied by the increase in absorption bands 4 and 2, indicating the $-\text{CH}_3$ groups are successively substituted by -OH groups on the PDMS surface.

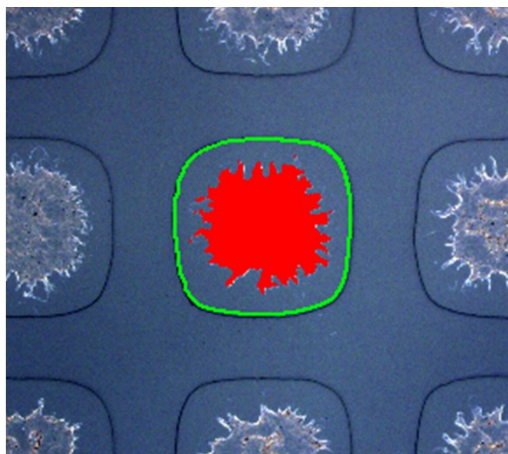


Fig. S3 Image of the AgNWs on the patterned PDMS after the color segmentations by using the software of Image-Pro Plus. The AgNW area and the boundary of the exposed PDMS were indicated by red and green color, respectively. The area fraction A_F was estimated by dividing the number of the red pixels by that of the pixels contained in the green wireframe.

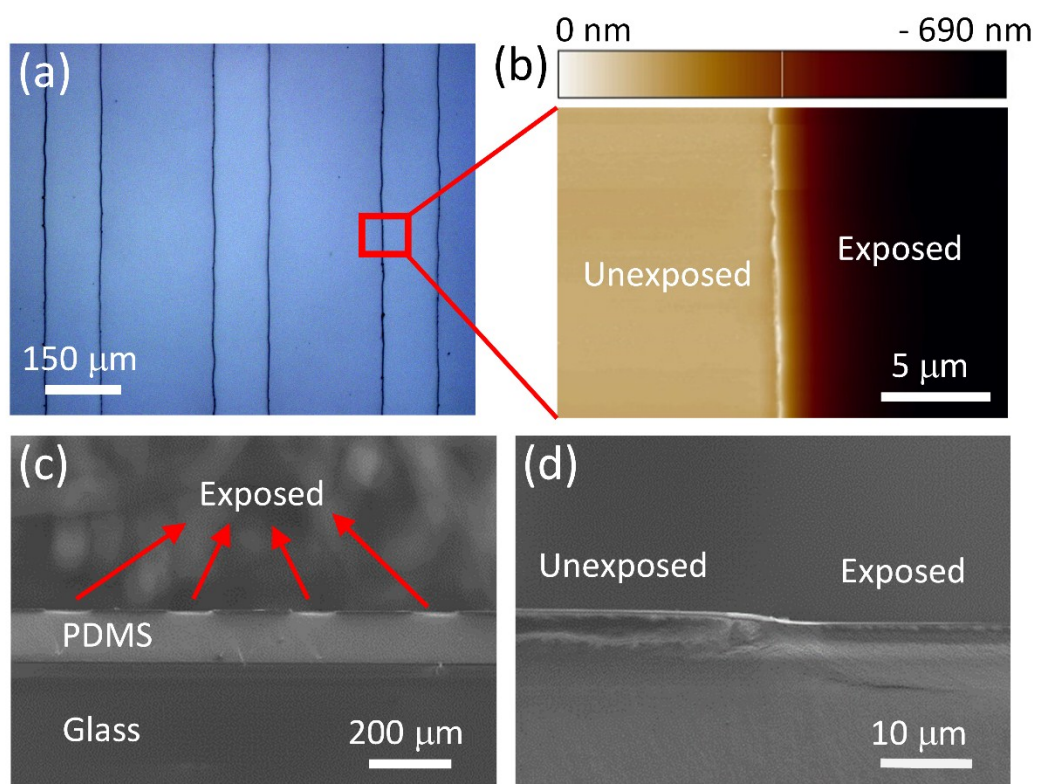


Fig. S4 (a) OM and (b) AFM images of the patterned PDMS. (c) Cross-section SEM image of the patterned PDMS on glass and (d) corresponding enlarged image.

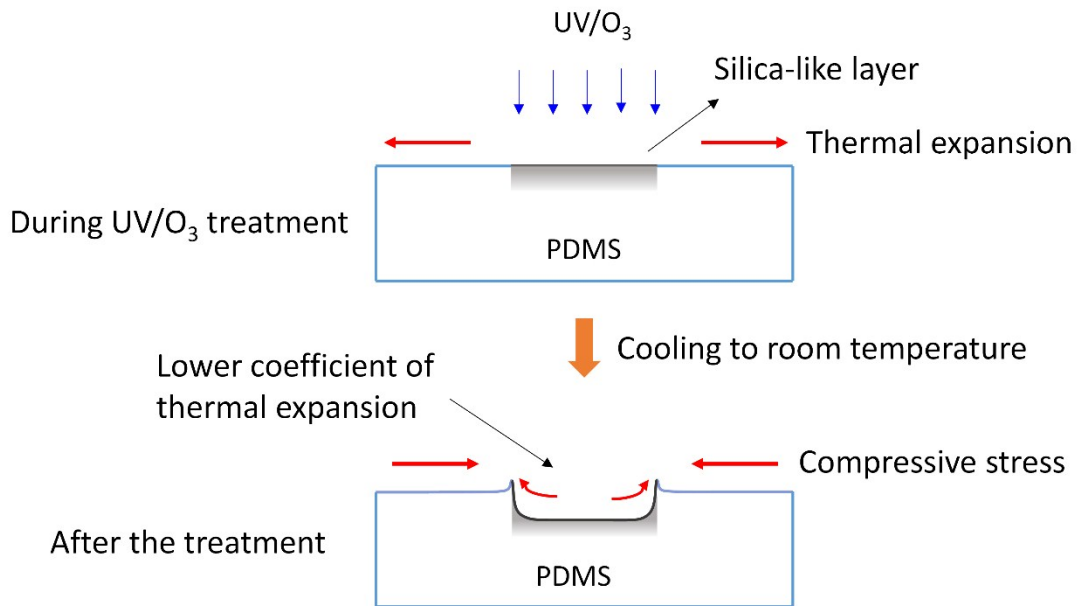


Fig. S5 Schematic of the subsidence and nano-ridge formation of the PDMS after UV/O₃ treatment

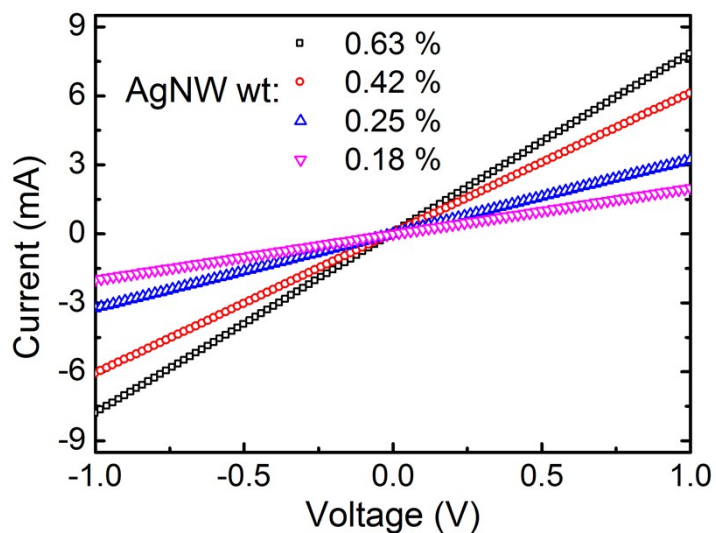


Fig. S6 Typical current-voltage (I - V) characteristics of the patterned AgNWs on the PDMS with different weight ratio of AgNW in the dispersions (pattern width: 150 μm , length: 2000 μm). The two-point probe method was used for the I - V curve measurements using a probe station (CASCADE SUMIT 12000). In Figure 3, the sheet resistances were calculated from the measured I - V curves by considering the size of patterns ($R_s = V/I * W/L$). W and L are width and length of the stripe pattern, respectively.

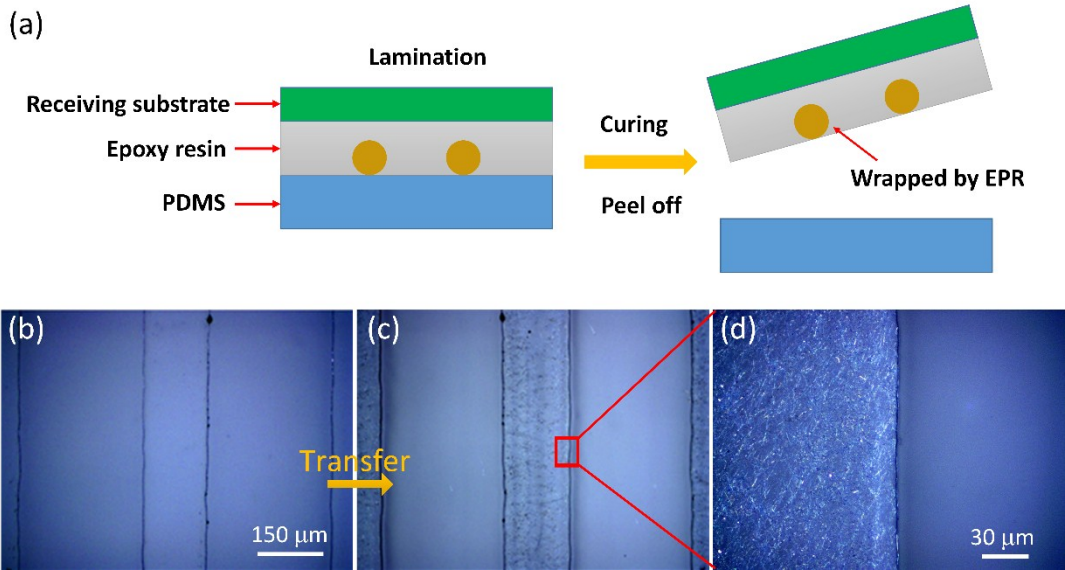


Fig. S7 (a) Schematic of the transfer process of AgNWs. OM images of (b) the PDMS substrate after the transfer process and (c) the transferred patterns of AgNW on the receiving PET, and (d) corresponding enlarge OM image.

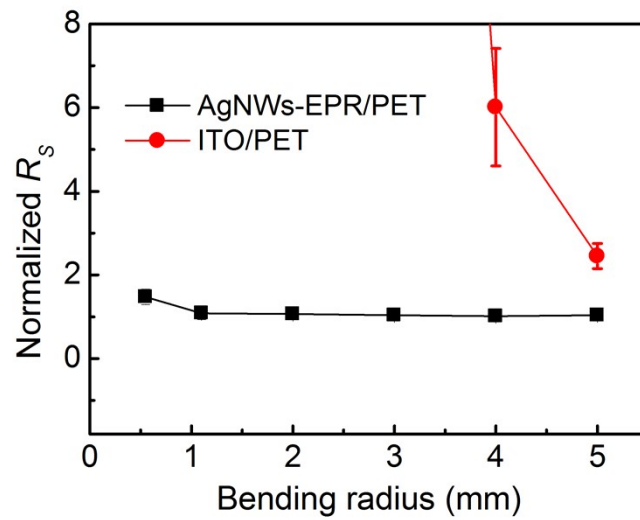


Fig. S8 R_s variation of the AgNWs-EPR on PET as a function of radius of tensile bending

The AgNWs-EPR/PET film exhibits a better flexibility compared with the commercial ITO film. The sheet resistance R_s of the AgNWs-EPR/PET only increases by 8.3% for 1 mm bending radius while the ITO film on PET shows a sharp increase of R_s (about 600%) for 4 mm bending radius, as shown in Fig. S8.

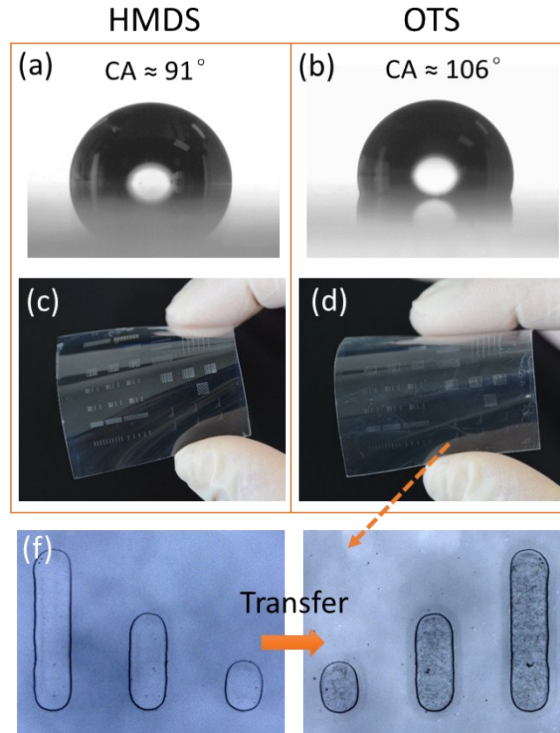


Fig. S9 (a)-(b) Water contact angle of the oxidized PDMS which have been treated by HMDS and OTS, respectively. (c)-(d) Transferred AgNW patterns on PET assisted by HMDS and OTS, respectively. (f) OM images of the PDMS after the transfer process and the transferred patterns of AgNW on the receiving PET.

We also tried using other material of OTS which is widely used as anti-adhesive agent. The OTS layer was prepared by immersing the PDMS into OTS solution (solvent: n-hexane). As expected, OTS turned the oxidized PDMS from hydrophilic to hydrophobic (corresponding $\gamma_s < 25 \text{ mJ/m}^2$), as shown in Fig. S9 (b). By the same process described in our manuscript, AgNW patterns were also transferred to the receiving substrate without residual PDMS (see Fig. S9 (d, f)).

Though OTS also affords good transferring, it should be noted that OTS may not be as good as HMDS, as indicated in Fig. S9 (c)-(d). Because OTS tends to polymerize in the solution, the oligomeric precursor and excess OTS molecules are absorbed on the PDMS surface during the liquid deposition. This phenomenon lowers the transmittance and causes non-uniformity of the transferred film (Fig. S9 (d)), and may results in a lower reliability in large area fabrication.

Acknowledgements

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References

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