Supplementary Information

Hybrid patterning of metal nanowire/polymer composites based on selective photocuring-and-transfer and kirigami cutting techniques for stretchable circuit application

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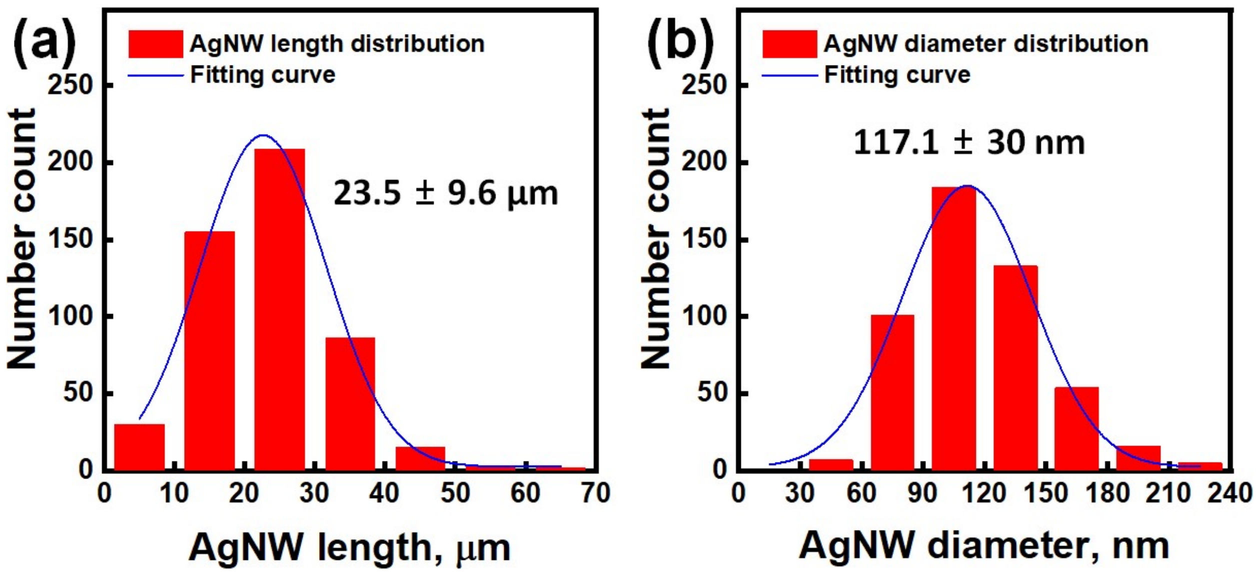

Fig. S1 (a) Length and (b) diameter distributions of the synthesized AgNWs (500 AgNWs measured).

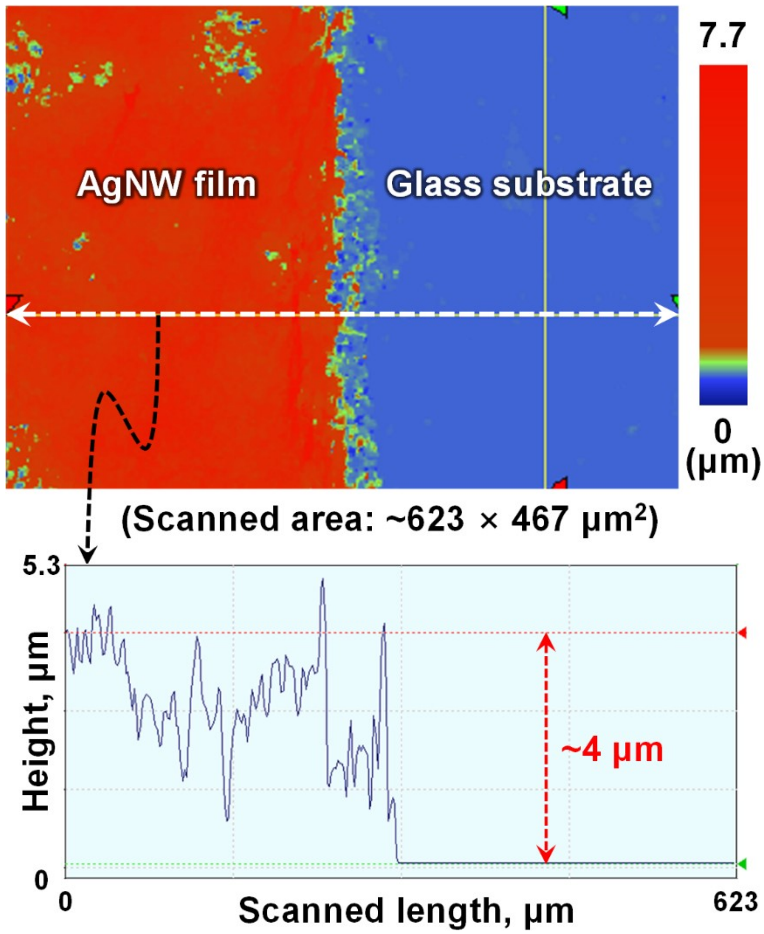

Fig. S2 Surface profiling images of the AgNW film coated on a glass substrate, showing its typical thickness of ~4 μm.

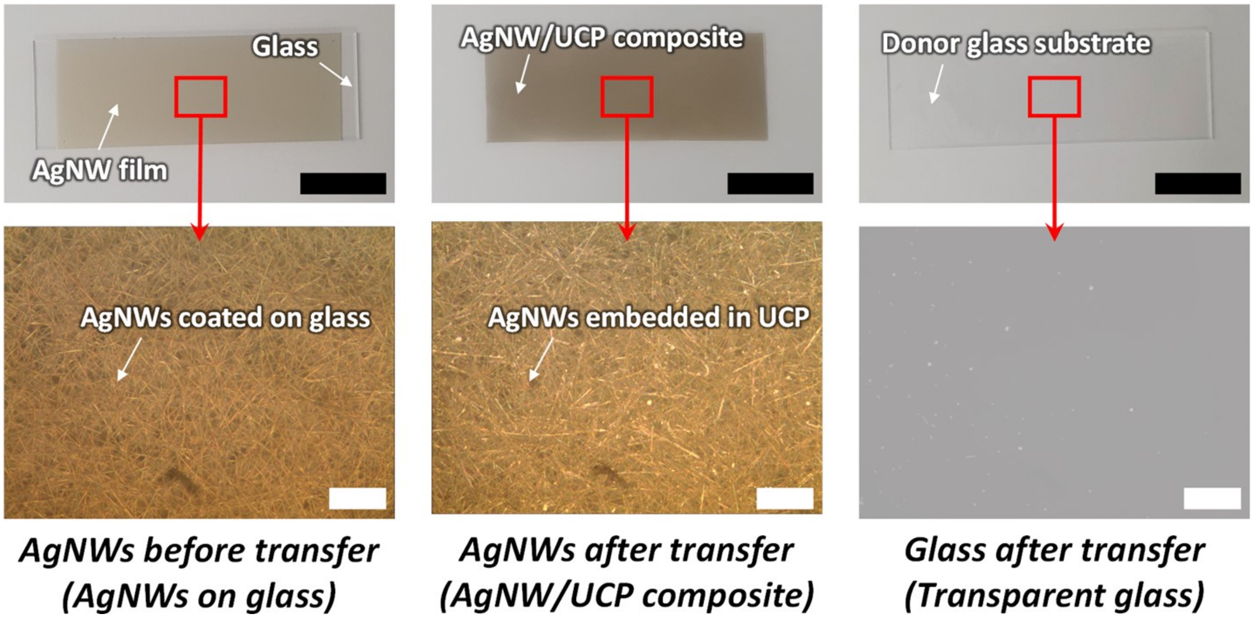

Fig. S3 Digital photographs and magnified optical microscope (OM) images of the surface morphologies of the AgNW network film before and after the embed-and-transfer process (scale bars: 20 mm (black), 20 μm (white)).

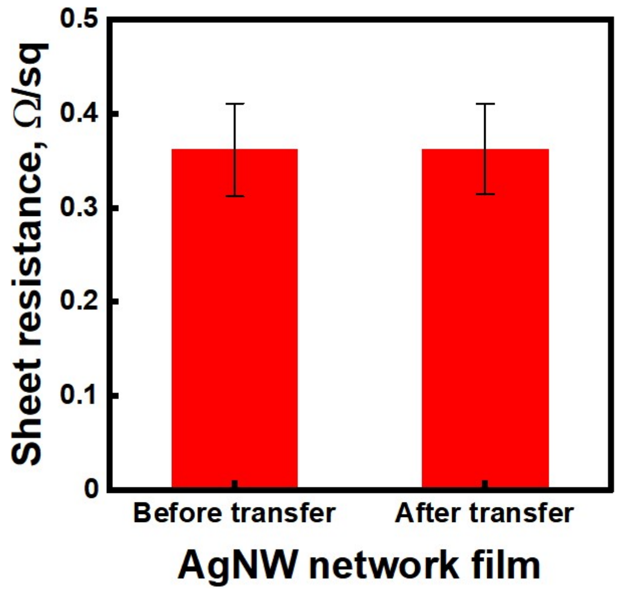

Fig. S4 Comparison of sheet resistance (R_s) of the AgNW network film before and after the embed-and-transfer process for 20 identical samples.

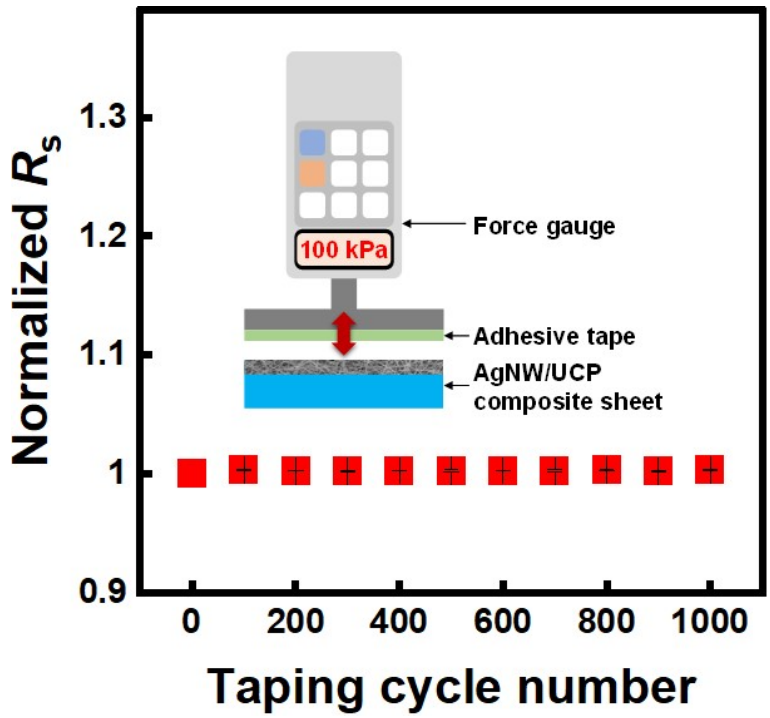

Fig. S5 Normalized sheet resistance values of the AgNW/UCP composite sheet under 1000 tape attach-and-detach cycles at a loading pressure of 100 kPa.

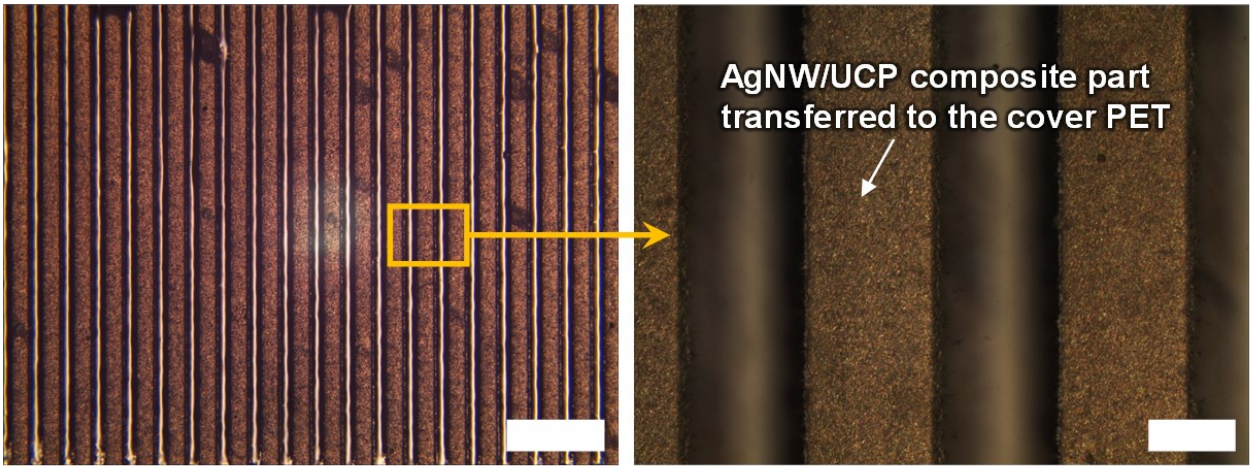

Fig. S6 Top-view OM images of the AgNW/UCP film parts transferred to the cover PET sheet during the selective photocuring-and-transfer (SPT) process (scale bars: 2 mm (left); 200 μm (right)).

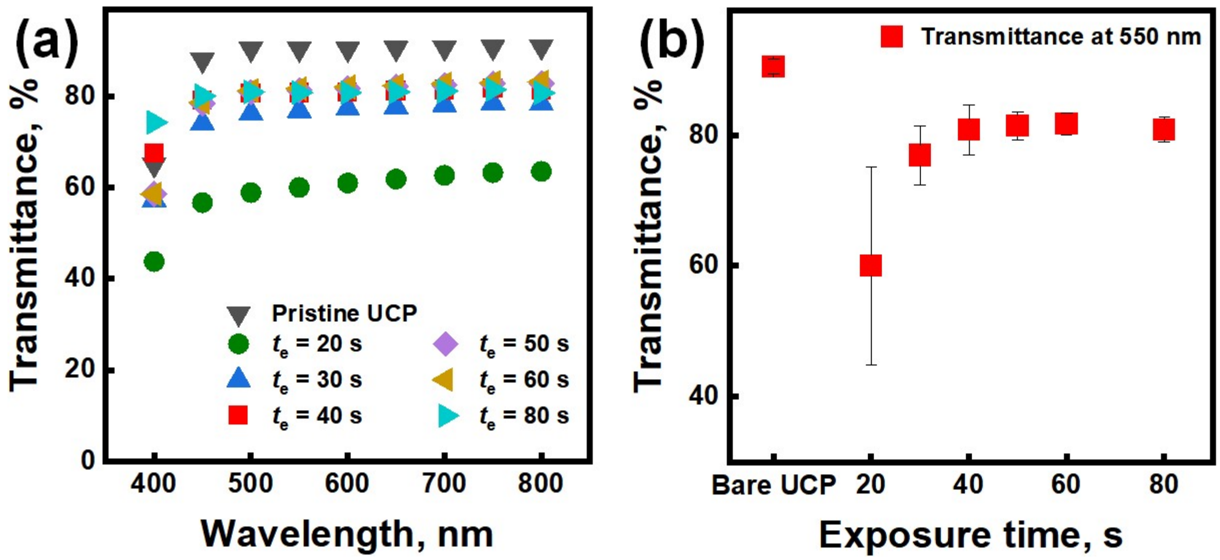

Fig. S7 Optical transmittance of the window region of the AgNW/UCP composite sheet prepared under various UV exposure times. (a) Average transmittance spectra in the wavelength range of 400 to 800 nm. (b) Transmittance values at a wavelength of 550 nm.

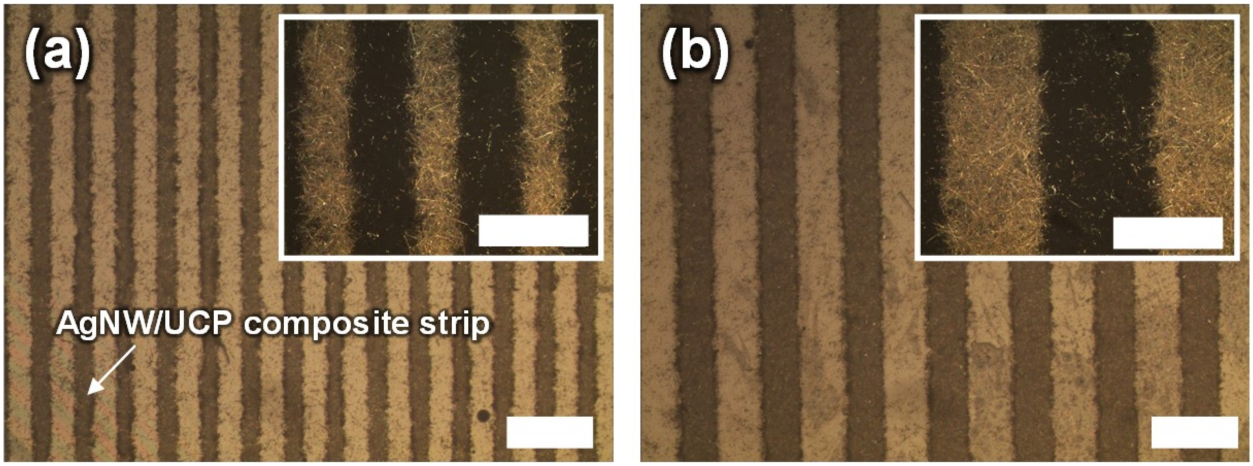

Fig. S8 Top-view OM images of the AgNW/UCP composite strips with the width of (a) 50 µm and (b) 100 µm (scale bars: 200 µm; inset: magnified OM images, scale bars: 100 µm).

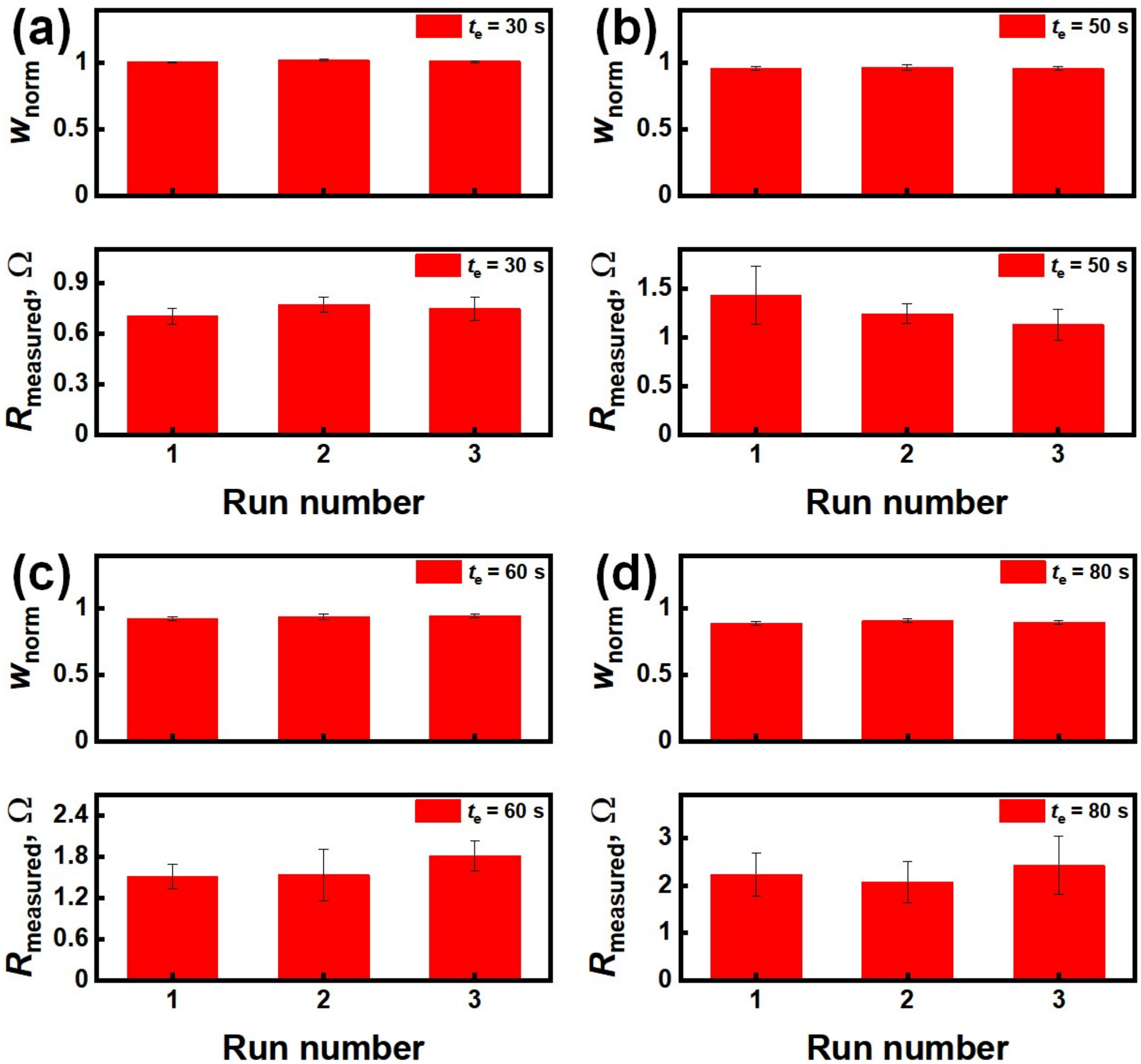

Fig. S9 Run-to-run process uniformity for the AgNW/UCP composite strips in terms of normalized strip width (w_{norm}) and measured resistance ($R_{measured}$) under various exposure times (t_e). (a) t_e = 30 s. (b) t_e = 50 s. (c) t_e = 60 s. (d) t_e = 80 s.

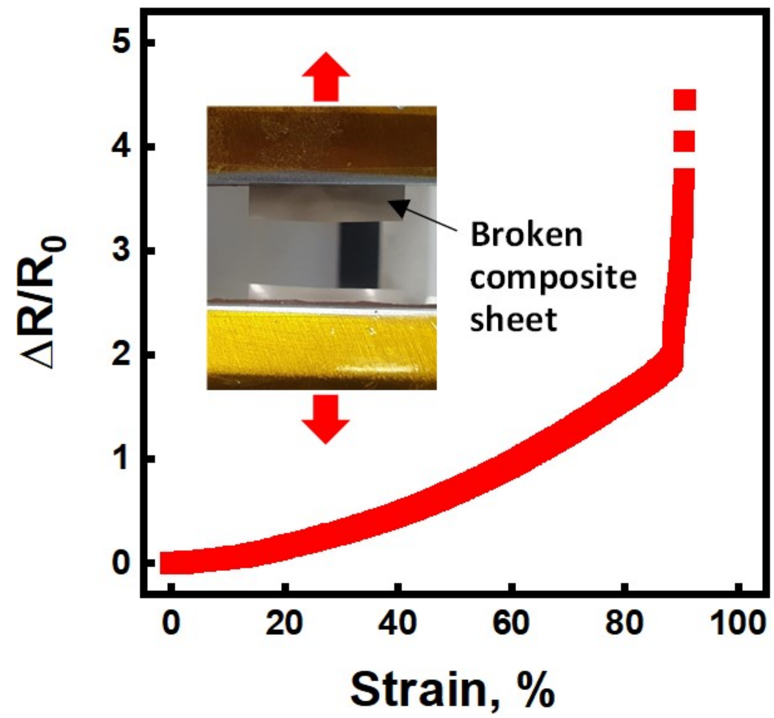

Fig. S10 Relative change in resistance ($\Delta R/R_0$) of the pristine AgNW/UCP composite sheet as a function of applied strain (inset: digital photograph of the composite sheet broken during the stretching test).

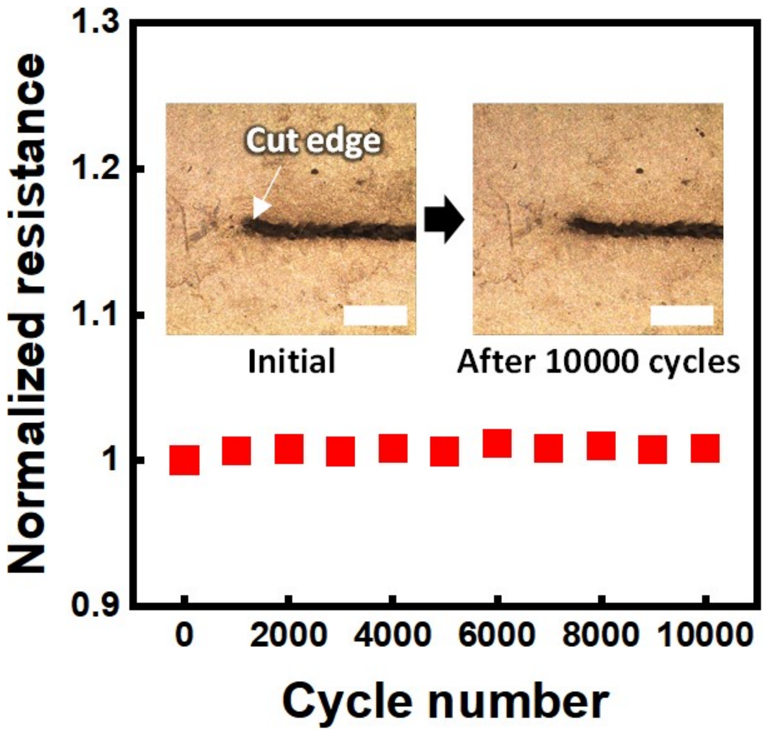

Fig. S11 Normalized resistance ($R_{unloading}$ /R_0) of the kirigami AgNW/UCP composite evaluated every 1000 cycles during 10000 stretching cycles at 100% strain, showing the long-term performance stability of the stretchable composite conductor (inset: microscope images of the cut edge region before and after 10000 stretching cycles (scale bars: 300 μm)).

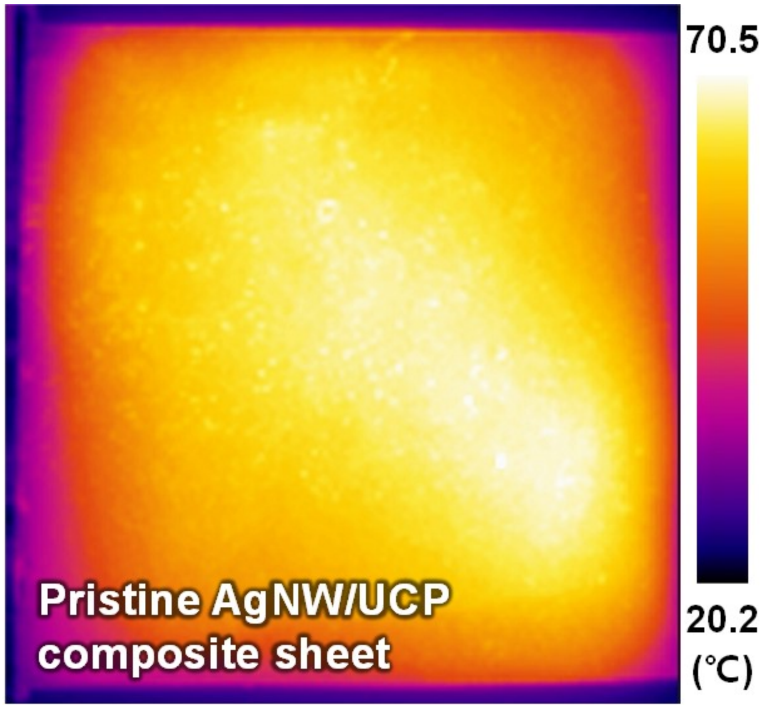

Fig. S12 Thermal camera image of the pristine AgNW/UCP composite conductor without kirigami cuts at an input voltage of 1.5 V.

The pristine AgNW/UCP heater exhibited higher maximum temperature (~70.5 ℃) compared to that of the kirigami-patterned stretchable AgNW/UCP conductor under the same input voltage (1.5 V) due to the lower resistance.

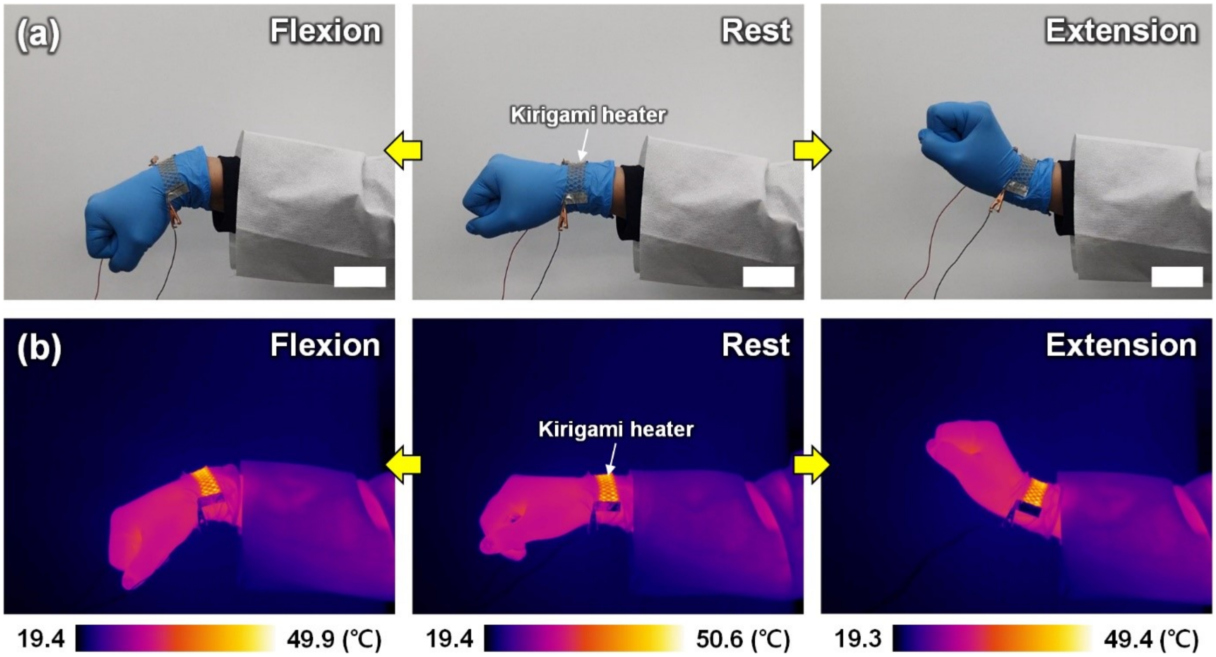

Fig. S13 Demonstration of the kirigami-patterned stretchable AgNW/UCP composite sheet as a wearable heater. (a) Digital photographs (scale bars: 50 mm) and (b) thermal camera images of the kirigami heater attached to the wrist of a volunteer under the dynamic wrist movements (applied voltage: 1.5 V).

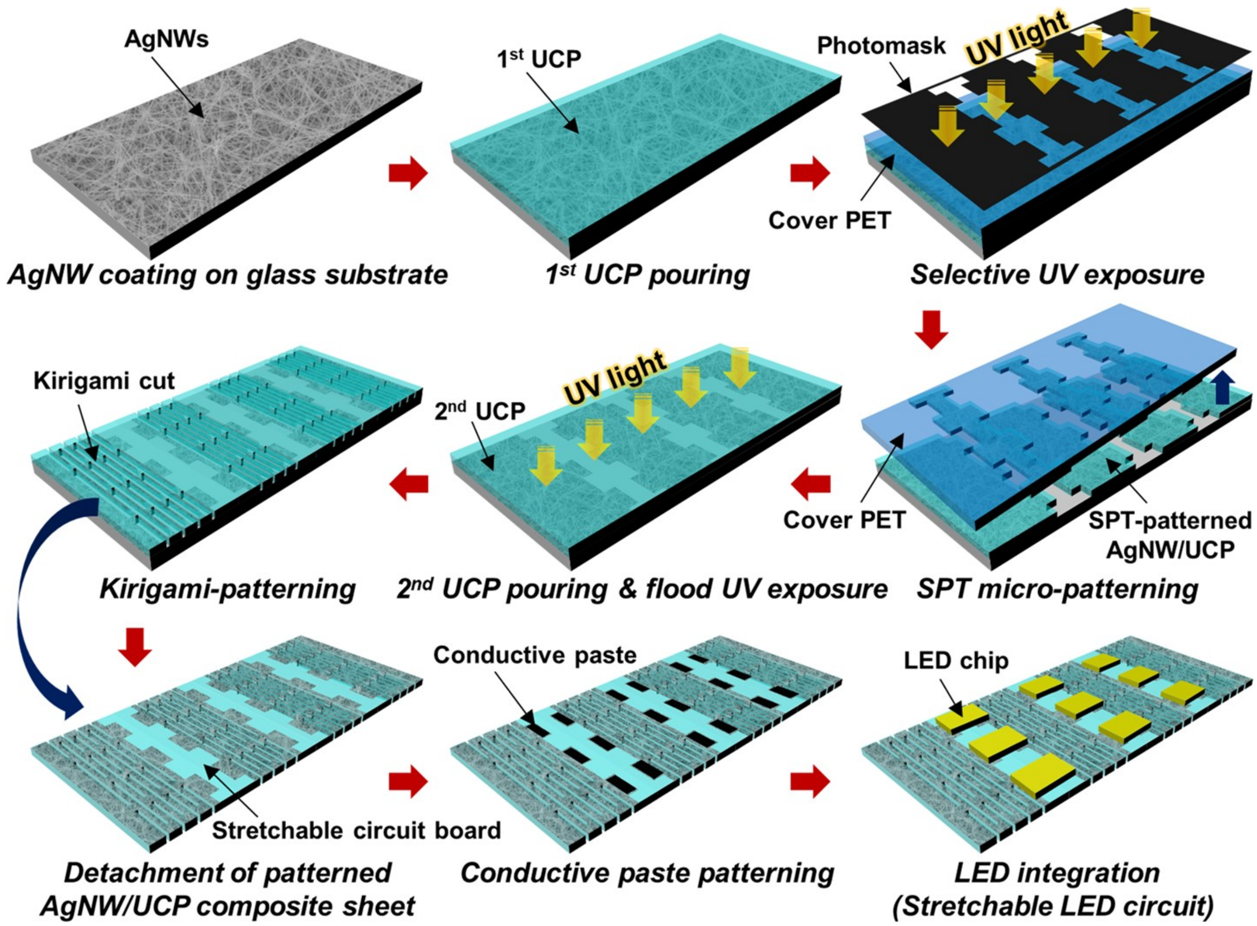

Fig. S14 Schematic illustration of the fabrication sequence of the stretchable LED circuit based on the hybrid patterning approach combining the SPT micro-patterning and kirigami cutting techniques.