

Supplementary Information

Rapid and economic preparation of wearable thermotherapy pad based on simple cut-patterning of metal foil supported by plastic sheets

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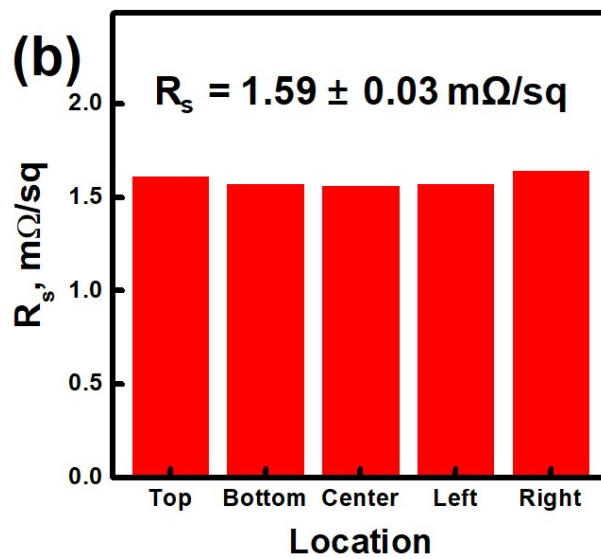
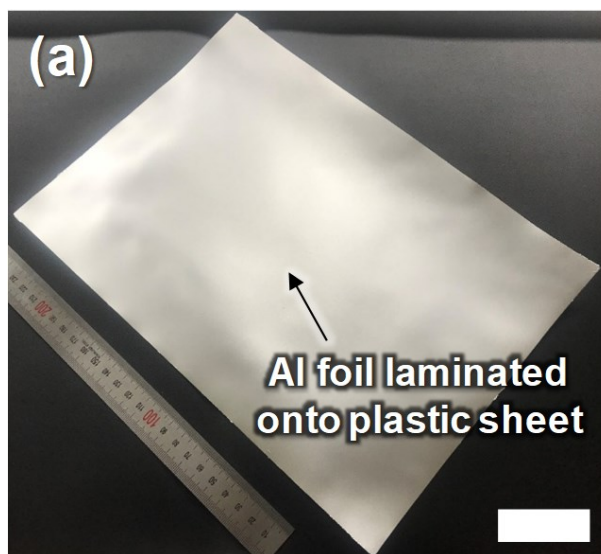


Fig. S1. Aluminum (Al) foil laminated onto an adhesive plastic sheet. (a) digital image (scale bar: 50 mm) and (b) sheet resistance (R_s) distribution on the Al foil.

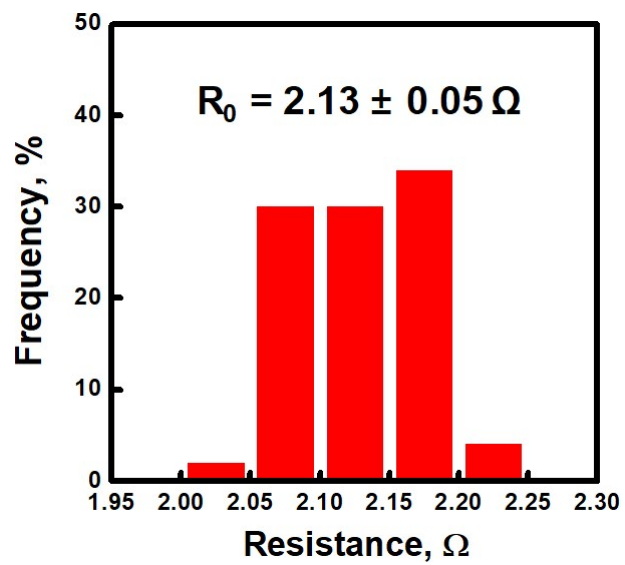


Fig. S2. Initial resistance (R_0) distribution of 50 identical plastic sheet/metal foil/plastic sheet (PMP) heaters.

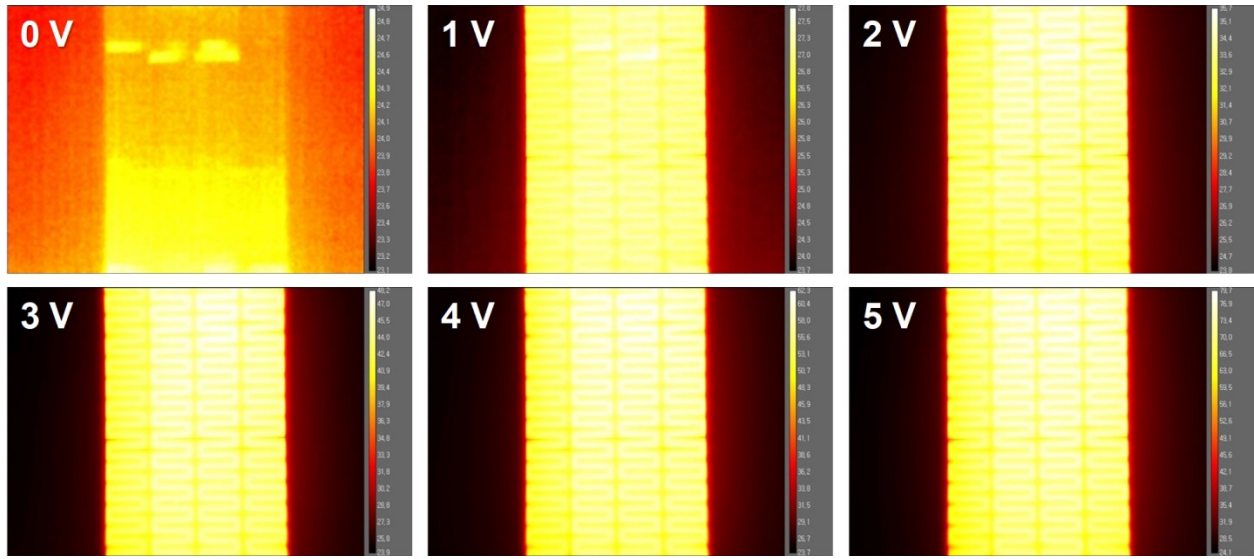


Fig. S3. Thermal camera images of the PMP heater ($w_c = 12$ mm) at various input voltages.

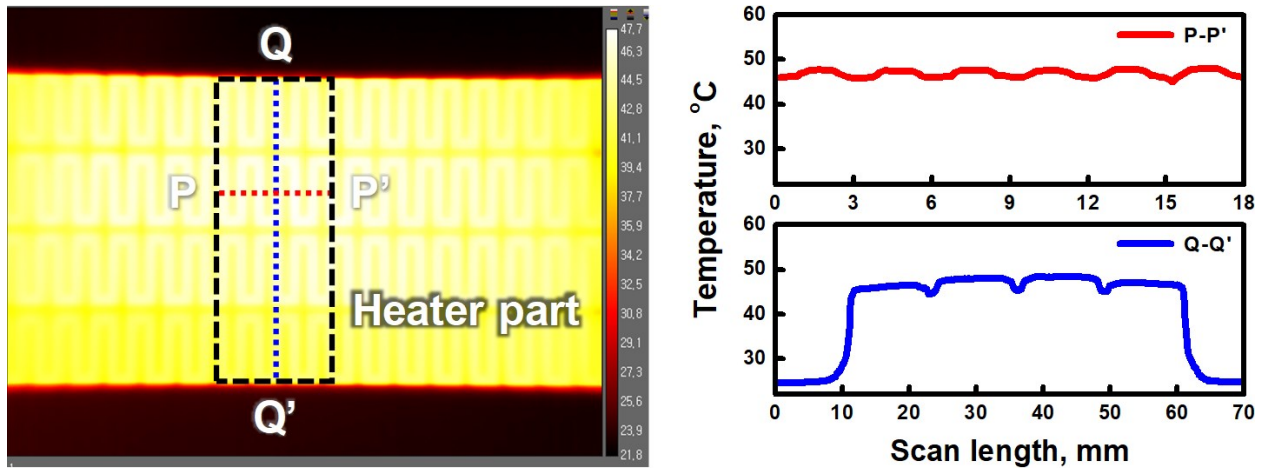


Fig. S4. Temperature profiles measured on the heater part of the PMP heater ($w_c = 12$ mm) along the P-P' and Q-Q' axes marked in the thermal camera image ($V_{in} = 3$ V).

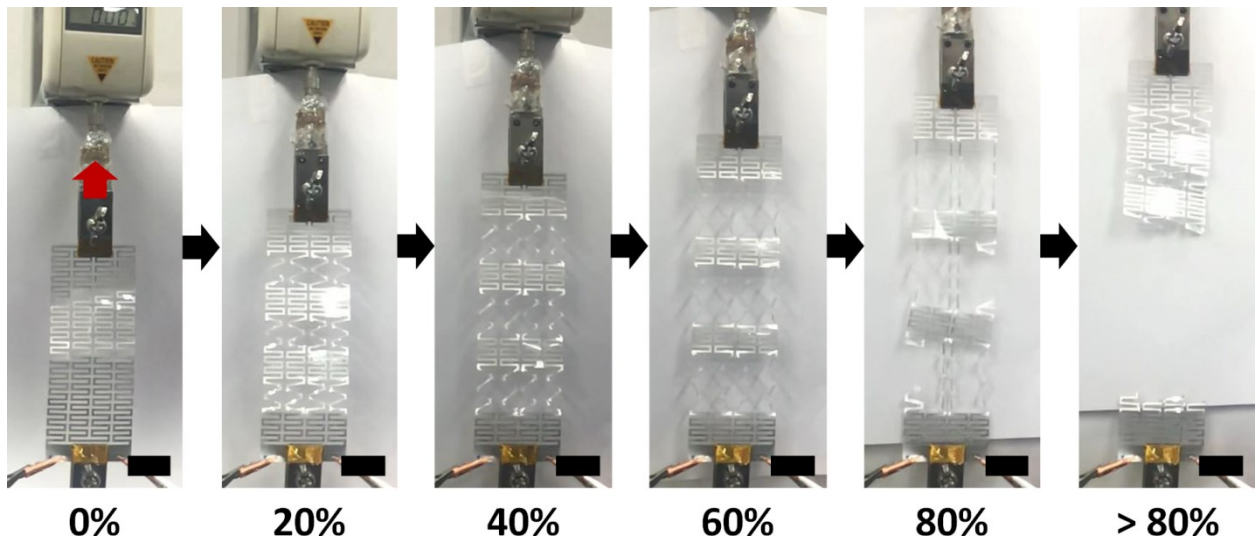


Fig. S5. Digital images of the PMP heater ($w_c = 12$ mm) at various strains (scale bars: 20 mm).

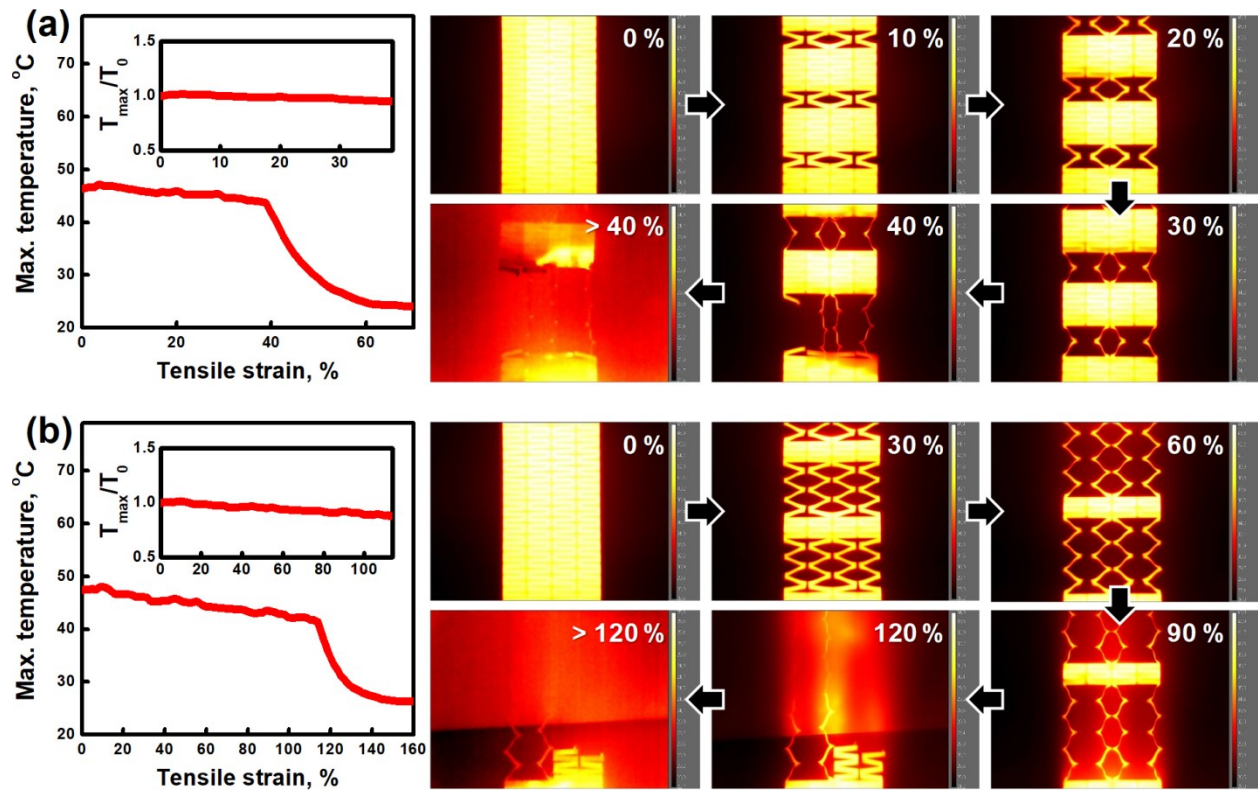


Fig. S6. Strain-dependent change in T_{\max} and corresponding thermal camera images of the PMP heaters with (a) $w_c = 6$ mm and (b) $w_c = 18$ mm ($V_{\text{in}} = 3$ V) (inset: normalized T_{\max} (T_{\max}/T_0) of the devices before mechanical failure).

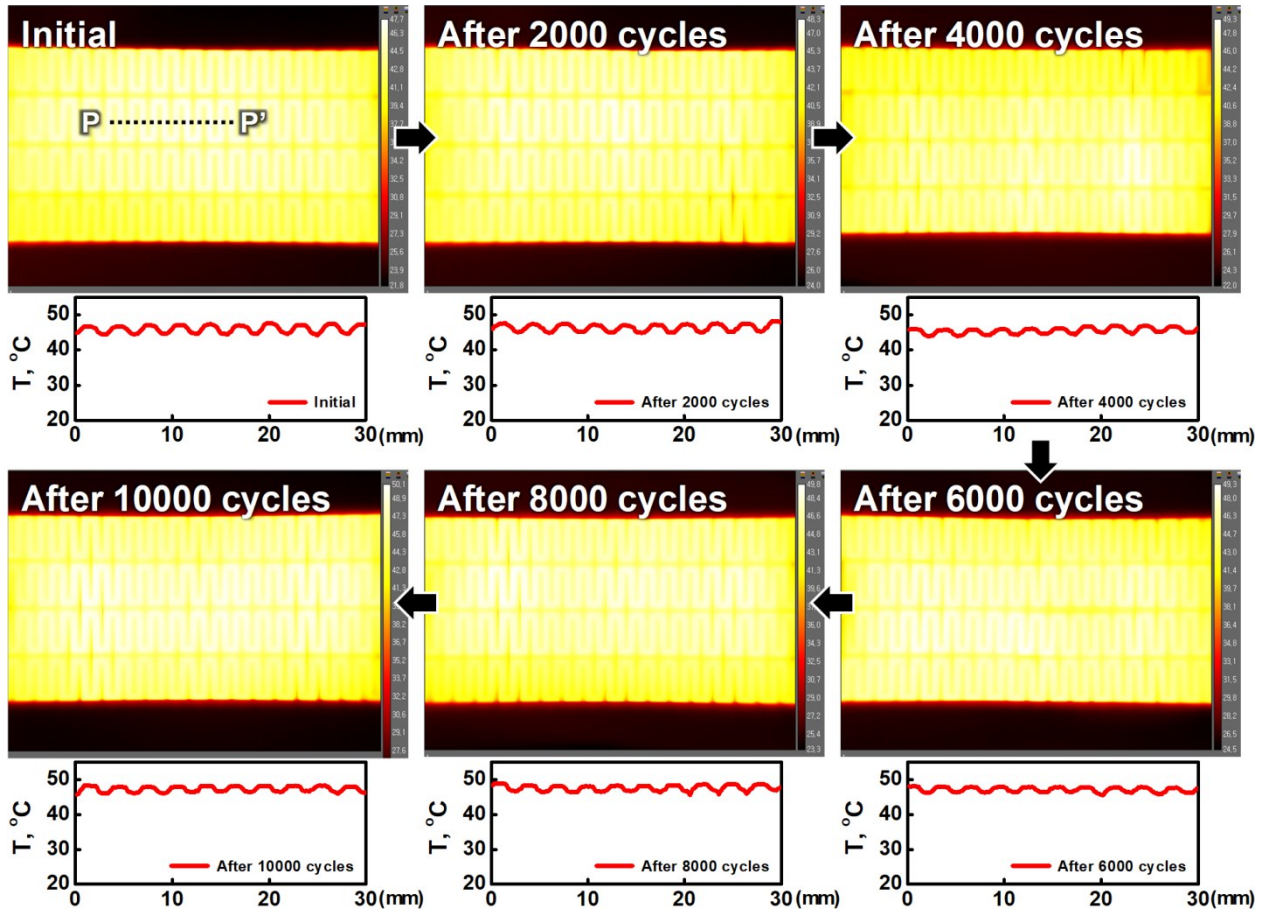


Fig. S7. Sequential thermal camera images and temperature profiles (P–P′) of the PMP heater ($w_c = 12$ mm) measured every 2000 cycles during the 10000 cyclic stretching/releasing test at 30% strain ($V_{in} = 3$ V).

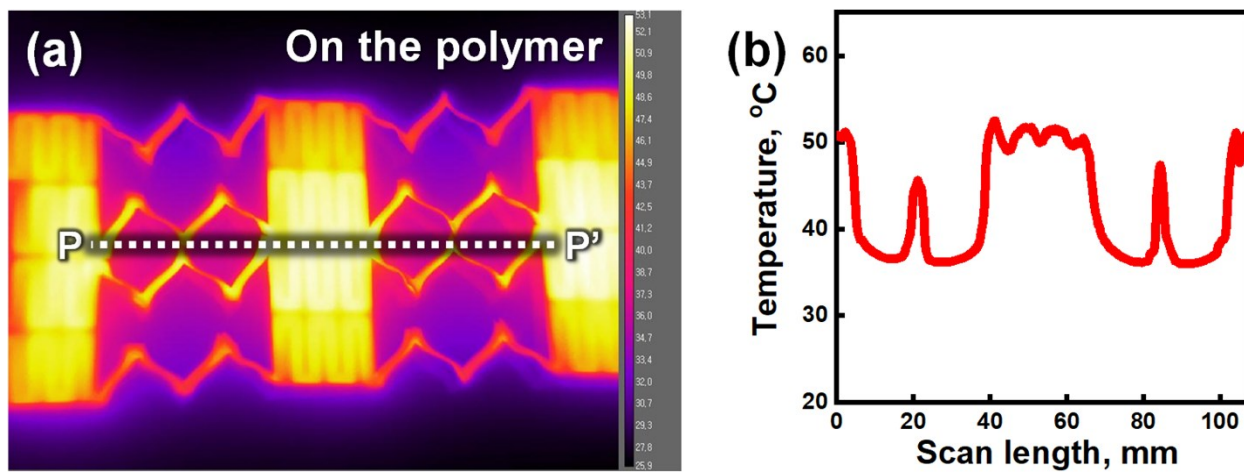


Fig. S8. Heat transfer behavior. (a) thermal camera image of the 50%-stretched PMP heater on the polymer and (b) temperature profile scanned along the P-P' line marked in (a).

It has been reported that the maximum strain caused by human motions can reach $\sim 50\%$.¹⁻³ In this regard, the heat transfer behavior in Fig. S8 suggests that the PMP heater can potentially be used as a practical wearable thermotherapy device.

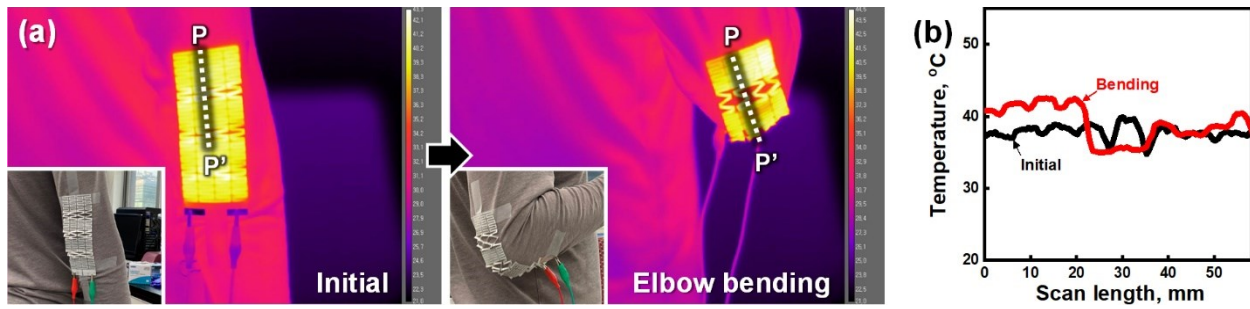


Fig. S9. Wearable PMP heater attached to the elbow. (a) thermal camera images of the device on the elbow joint in the initial and bending states (inset: corresponding digital images) and (b) temperature profiles scanned along the P-P' line marked in (a).

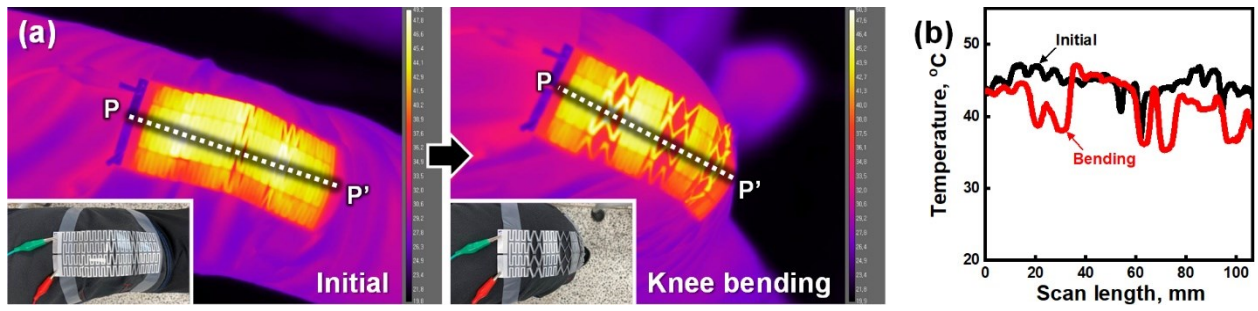


Fig. S10. Wearable PMP heater attached to the knee. (a) thermal camera images of the device on the knee joint in the initial and bending states (inset: corresponding digital images) and (b) temperature profiles scanned along the P-P' line marked in (a).

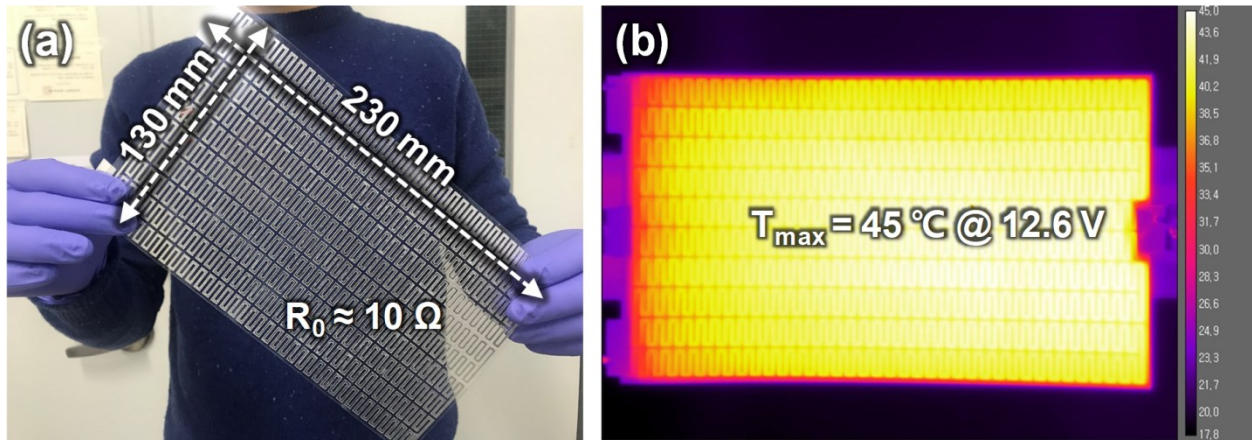


Fig. S11. Large-area heater fabrication. (a) digital image of the fabricated large-area heater ($230 \times 130 \text{ mm}^2$) and (b) thermal camera image of the device with an input voltage of $\approx 12.6 \text{ V}$.

Notes and references

- 1 C. Yan, J. Wang, W. Kang, M. Cui, X. Wang, C. Y. Foo, K. J. Chee and P. S. Lee, *Adv. Mater.*, 2014, **26**, 2022.
- 2 S. Gong, D. T. H. Lai, B. Su, K. J. Si, Z. Ma, L. W. Yap, P. Guo and W. Cheng, *Adv. Electron. Mater.*, 2015, **1**, 1400063.
- 3 S. Chen, Y. Wei, X. Yuan, Y. Lin and L. Liu, *J. Mater. Chem. C*, 2016, **4**, 4304.