



▶ **Seminar**
Research Center for Technology and Art

“ Large-area display textiles integrated with functional systems “, Nature 591, 240–245 (2021).

Xiang Shi et al., Fudan University

<https://doi.org/10.1038/s41586-021-03295-8>

Agenda

- 01** Introduction
- 01** Art Statement
- 02** Experiment Results
- 03** Connection

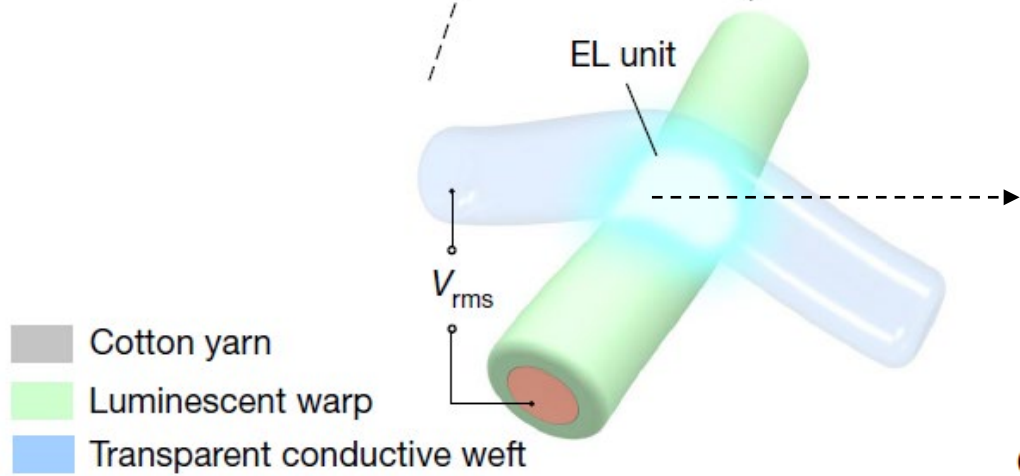
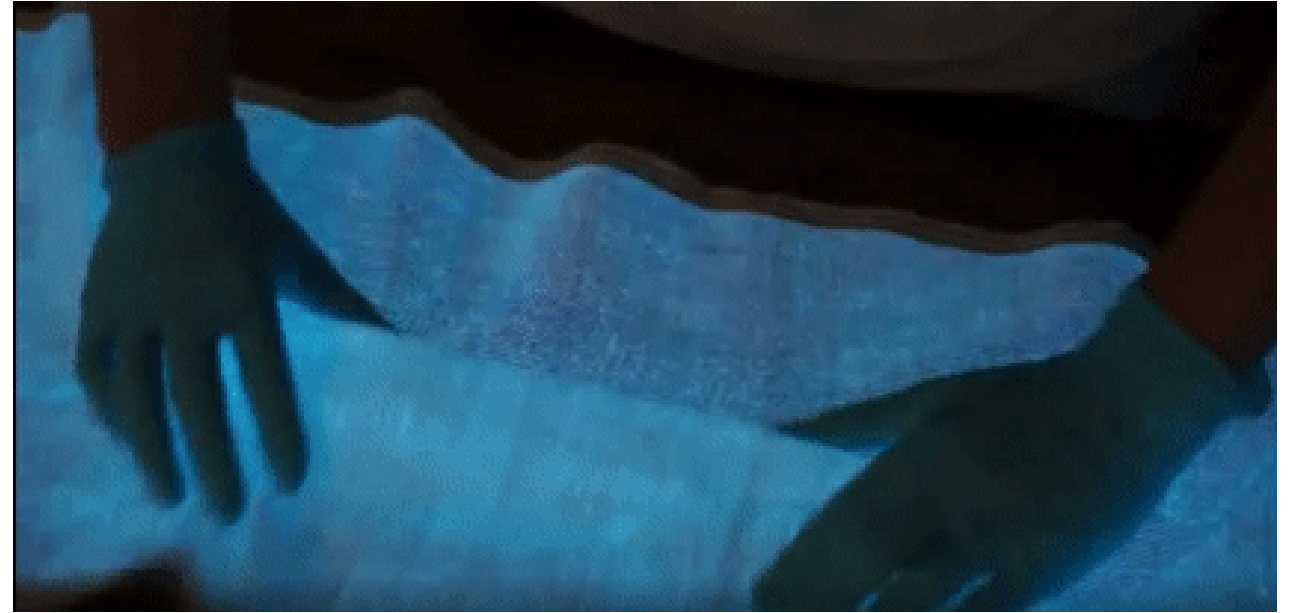
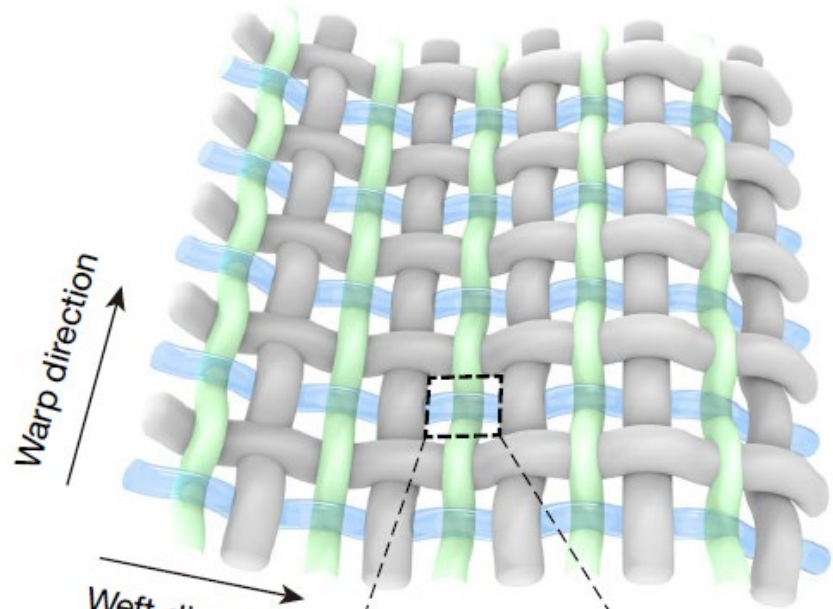
Introduction

“最近十多年來，人們希望織物不再是簡單的有某些單一功能，它還是智能的。什麼叫智能？實際上大家還是有一些爭議的，我理解的智能是它和環境是可以形成一個反饋的。”

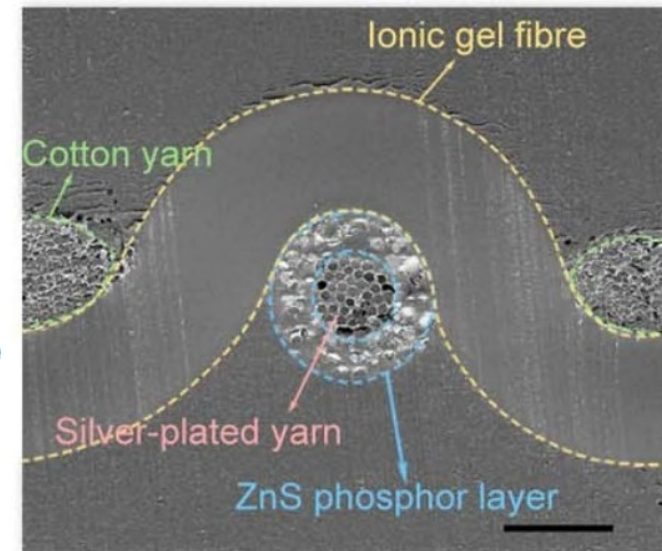
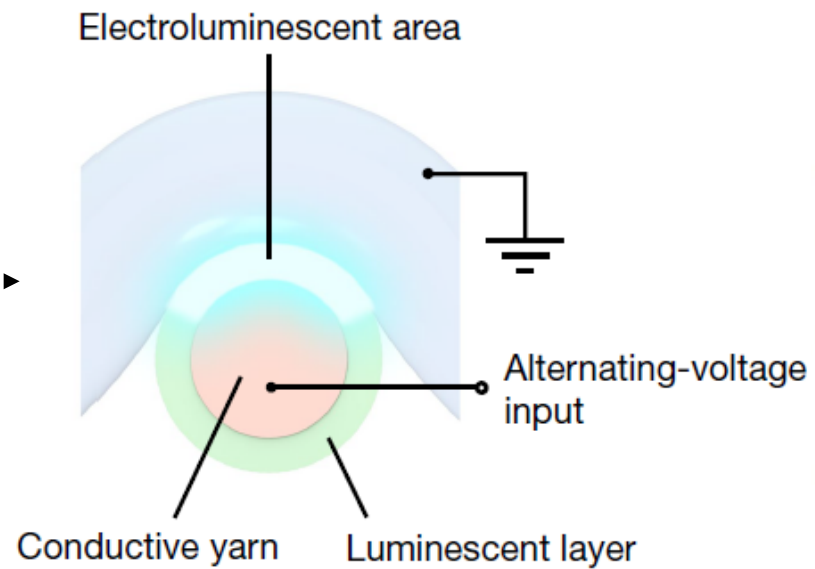
Prof. Peng, State Key Laboratory of Molecular Engineering of Polymers, Fudan University



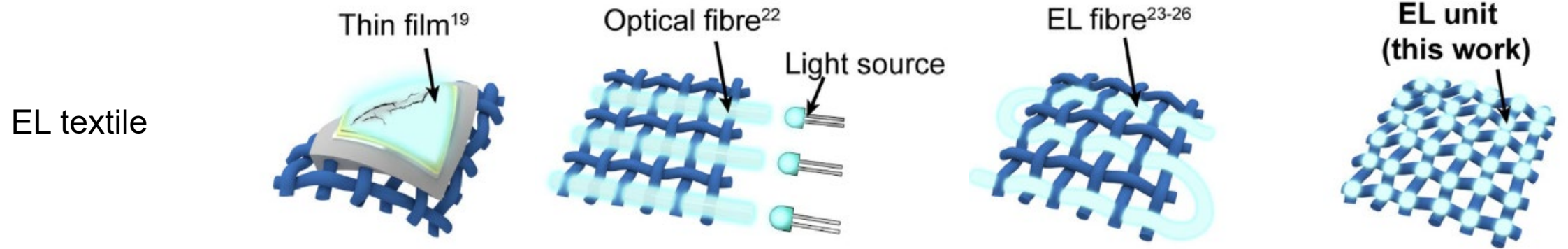
Art Statement - Monitor



- Cotton yarn
- Luminescent warp
- Transparent conductive weft



Introduction - Previous research



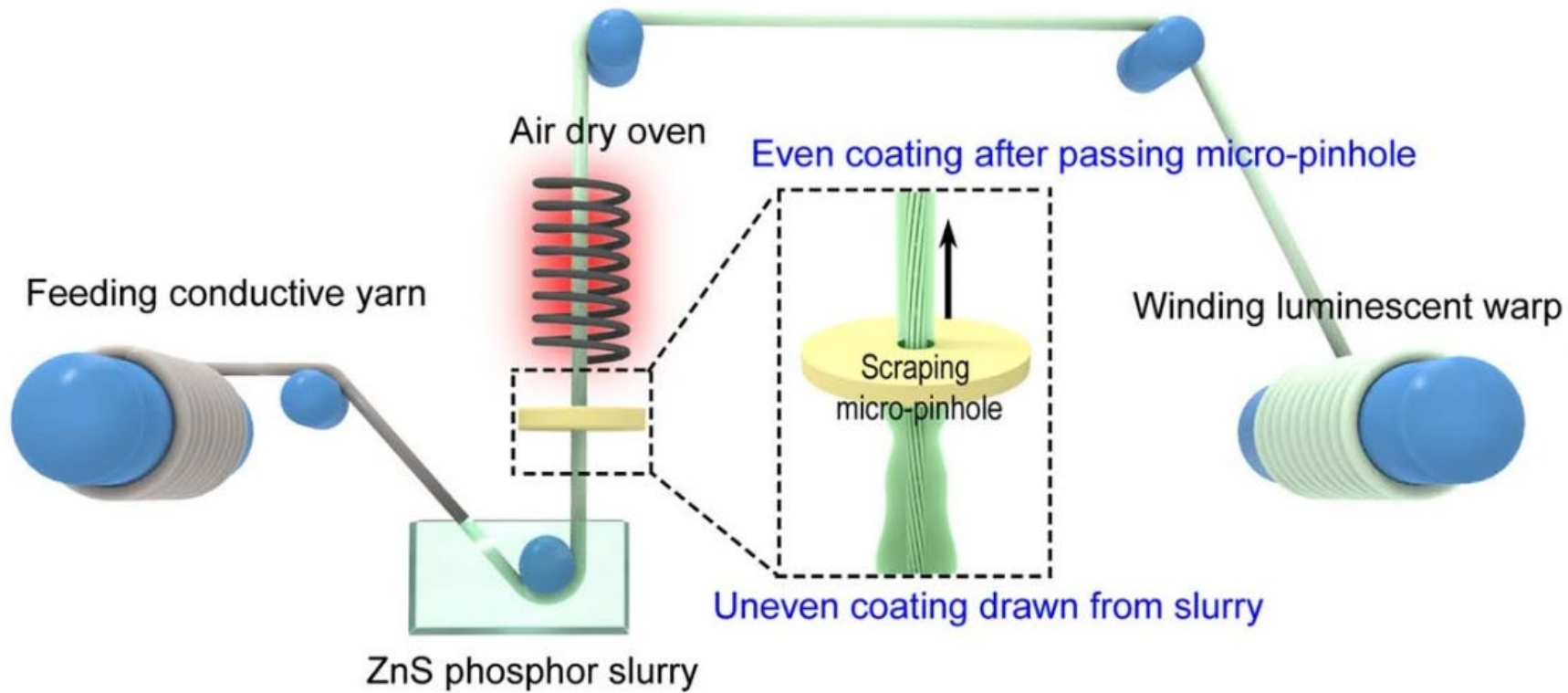
Material	PET substrate, metal electrodes	PMMA	metal wire	ZnS phosphor, polymer-based conductive fibre
Fabrication	vacuum deposition, spin coating	hot drawing	coating	weft-warp contacting
Working Mode	pixel display	limitation to lighting of woven pattern	limitation to lighting of woven pattern	pixel display
Breathability	low	high	high	high
Flexibility	rigid, brittle	rigid, brittle	flexible	flexible
Washing Stability	N/A	N/A	N/A	stable

1.*PET, polyethylene terephthalate; PMMA, polymethyl methacrylate. 5

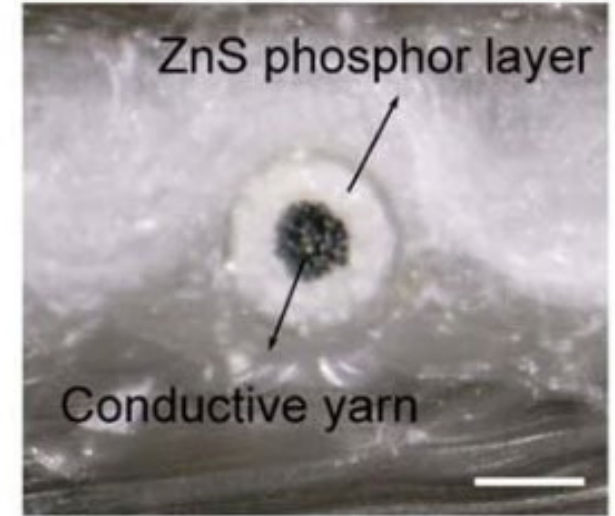
Art Statement - Monitor

- Manufacturing Technology

a

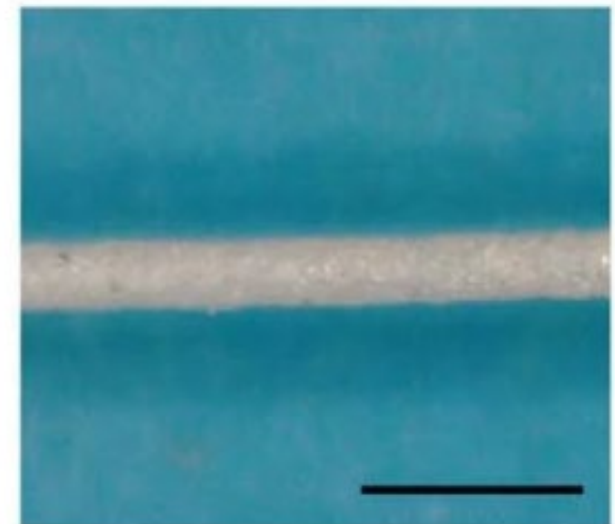


c



Scale bar: 1 mm

b



Scale bar: 200 μm

Art Statement - Monitor

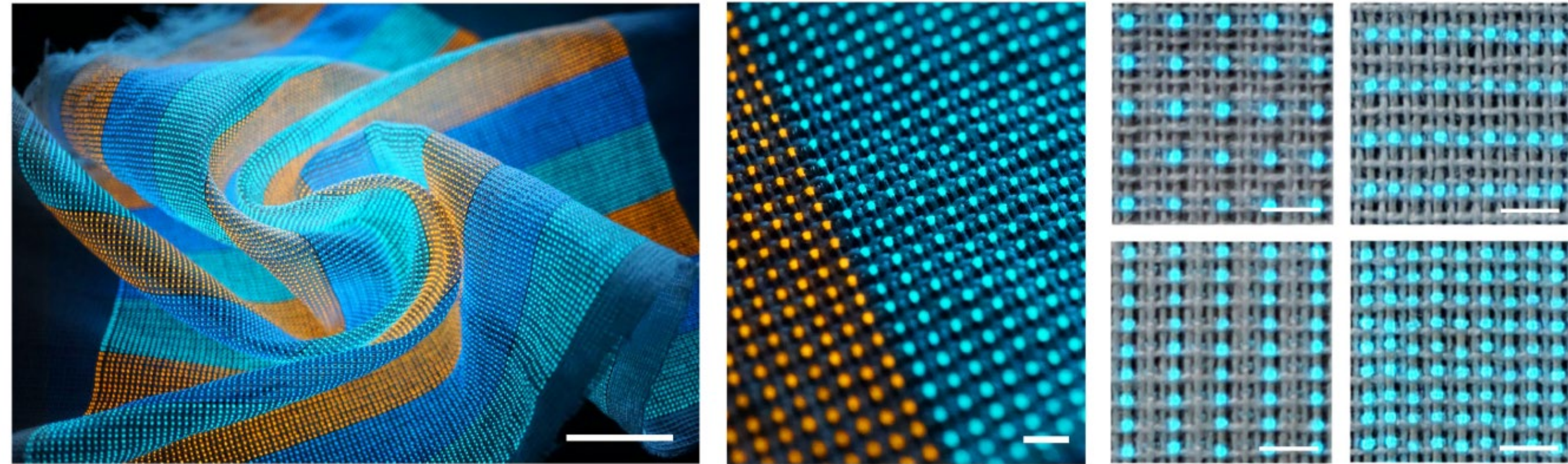
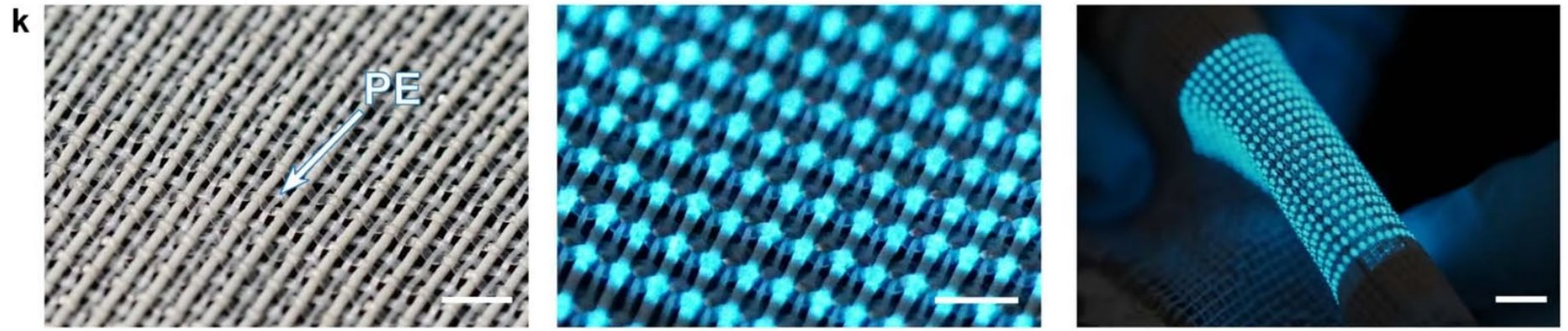
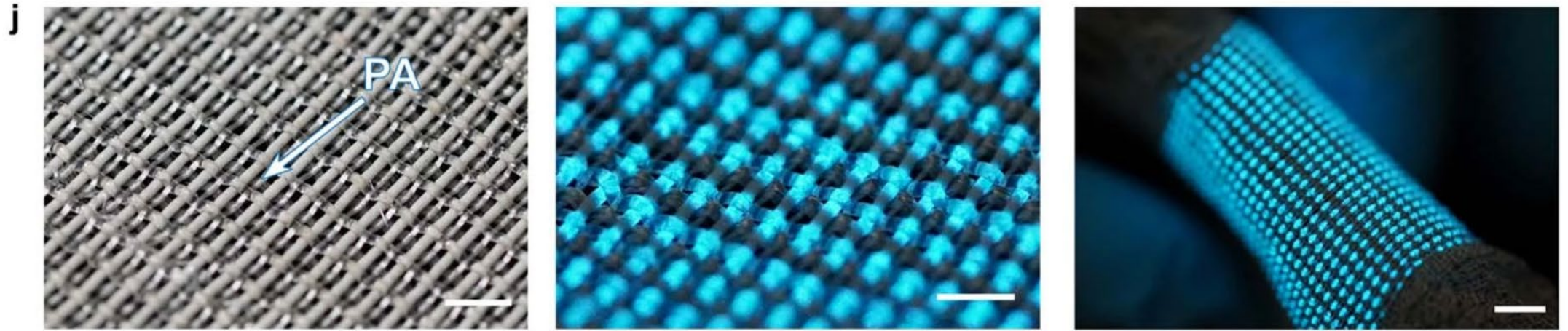


Fig. Structure and electroluminescence performance of the display textile (Scale bar: 2 mm)

Art Statement - Monitor

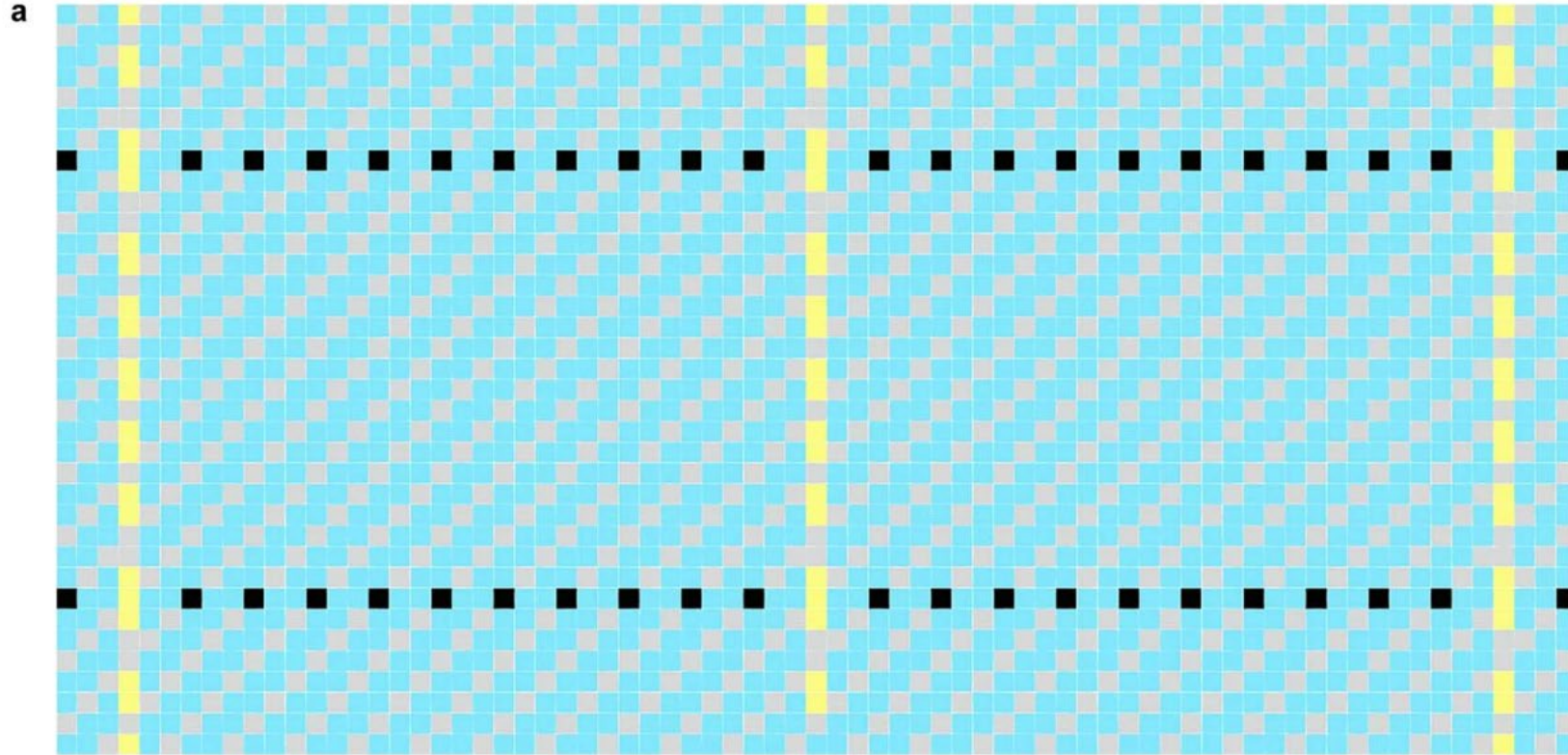


Scale bar: 2 cm

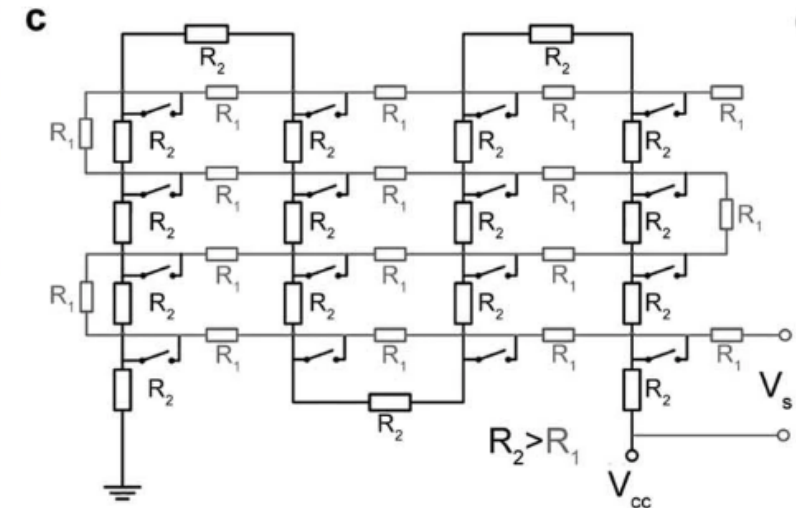
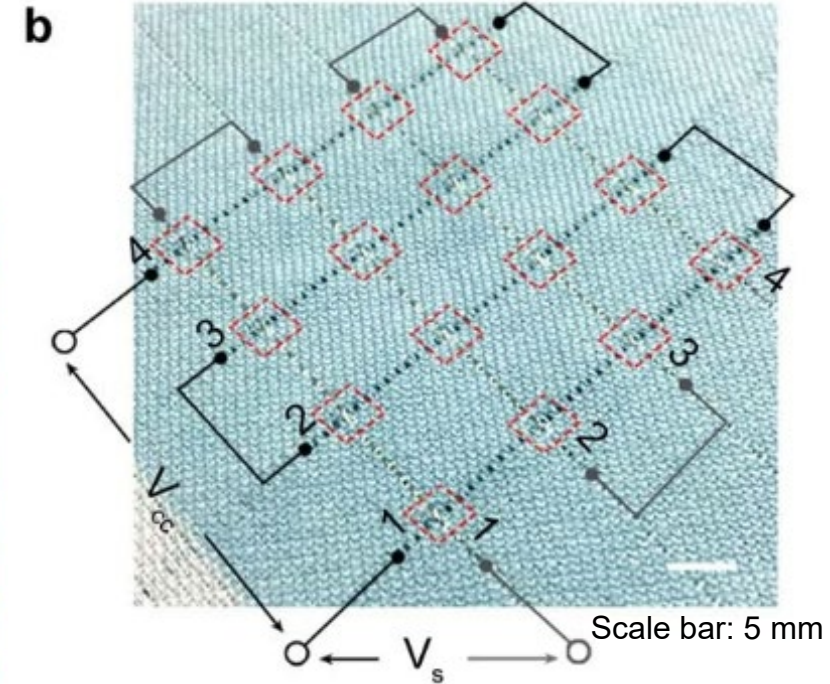
Scale bar: 2 cm

Scale bar: 5 cm

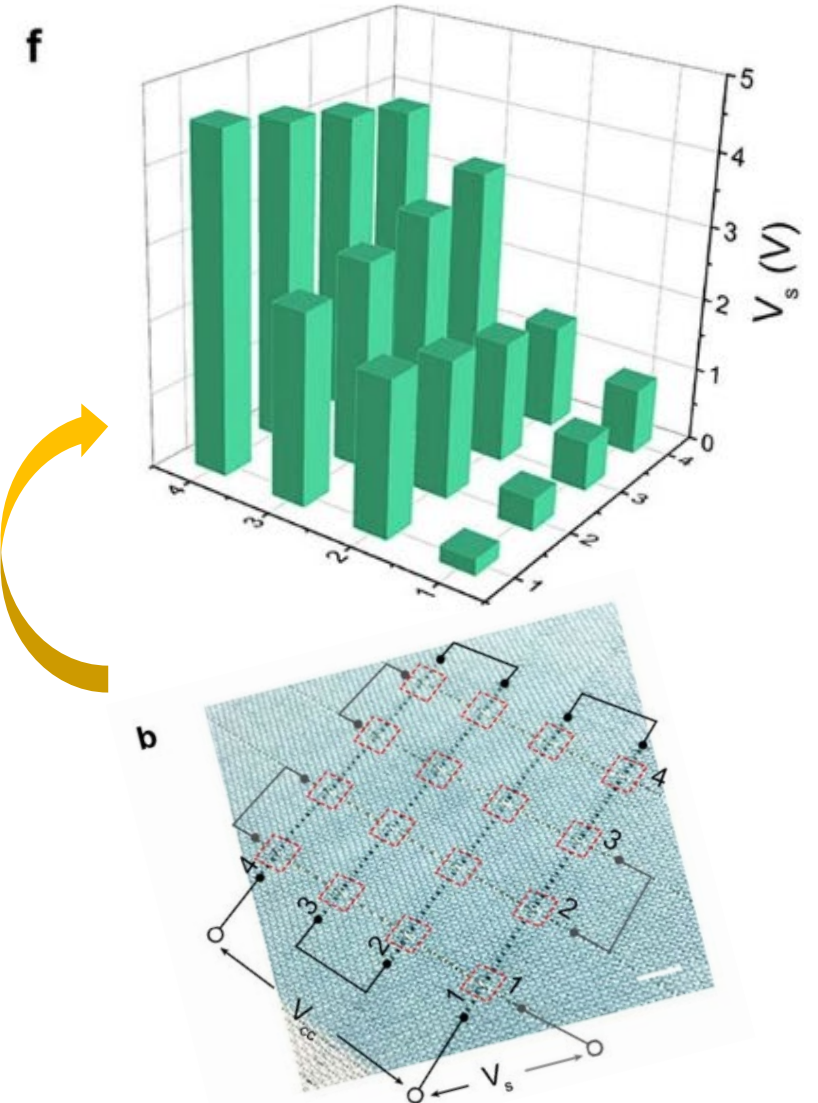
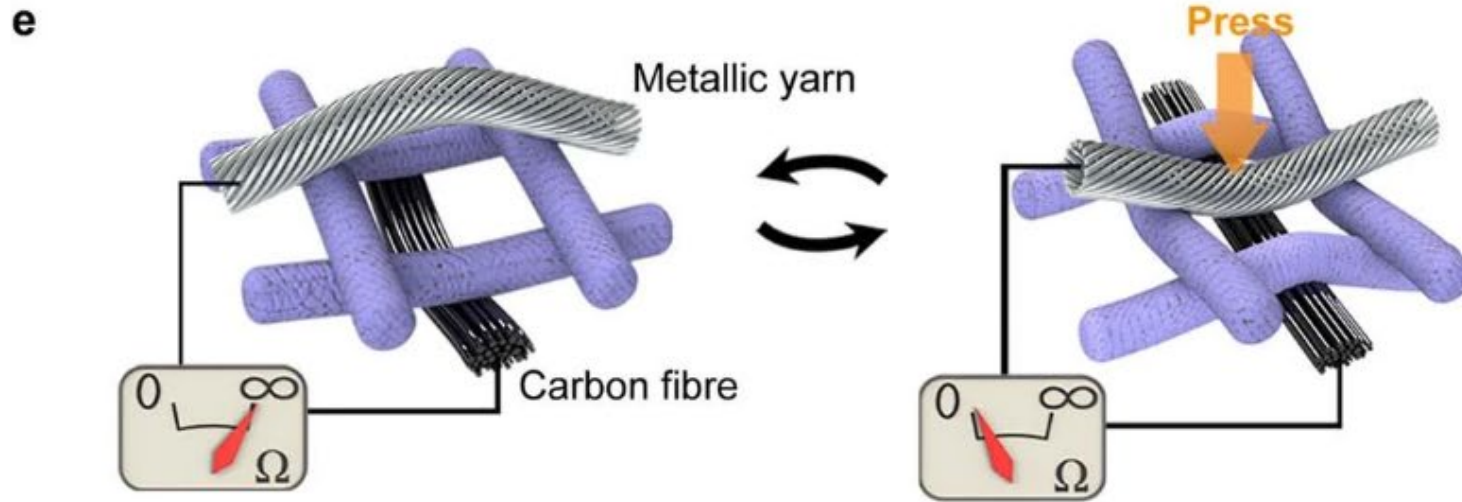
Art Statement - Textile Keyboard



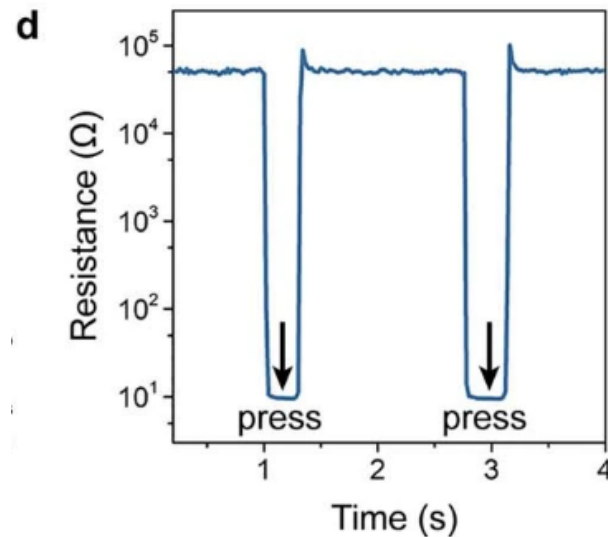
a, Weave diagram of the textile keyboard (yellow: Ag-plated fibre, black: carbon fibre, blue: cotton yarn, grey: cotton yarn).



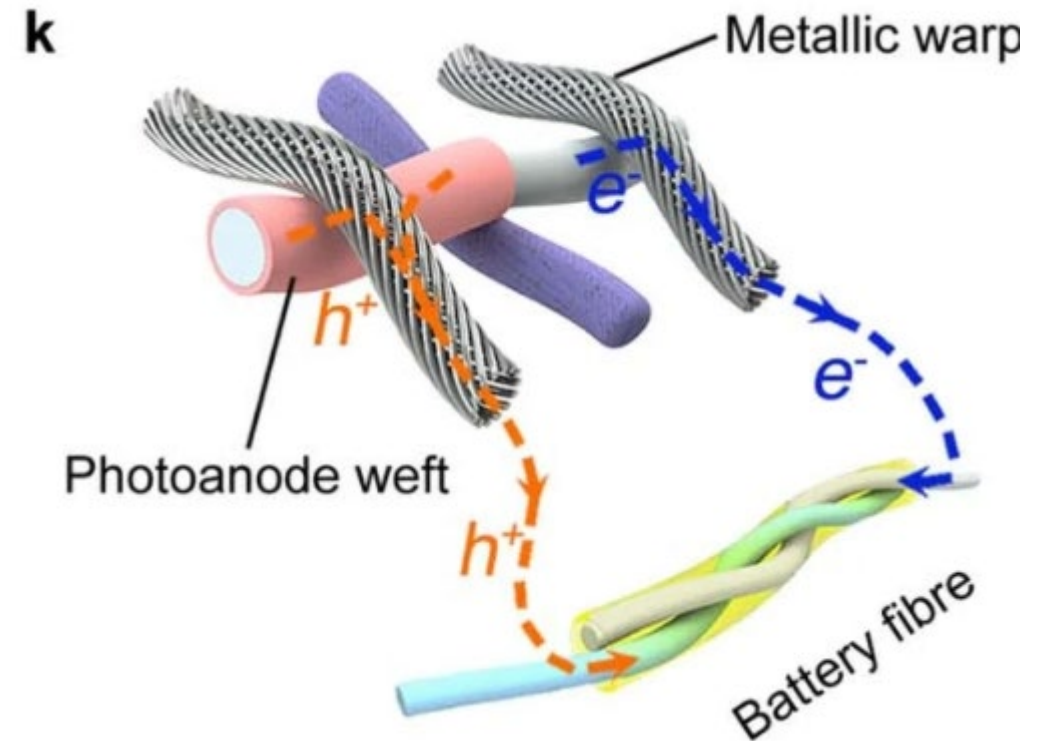
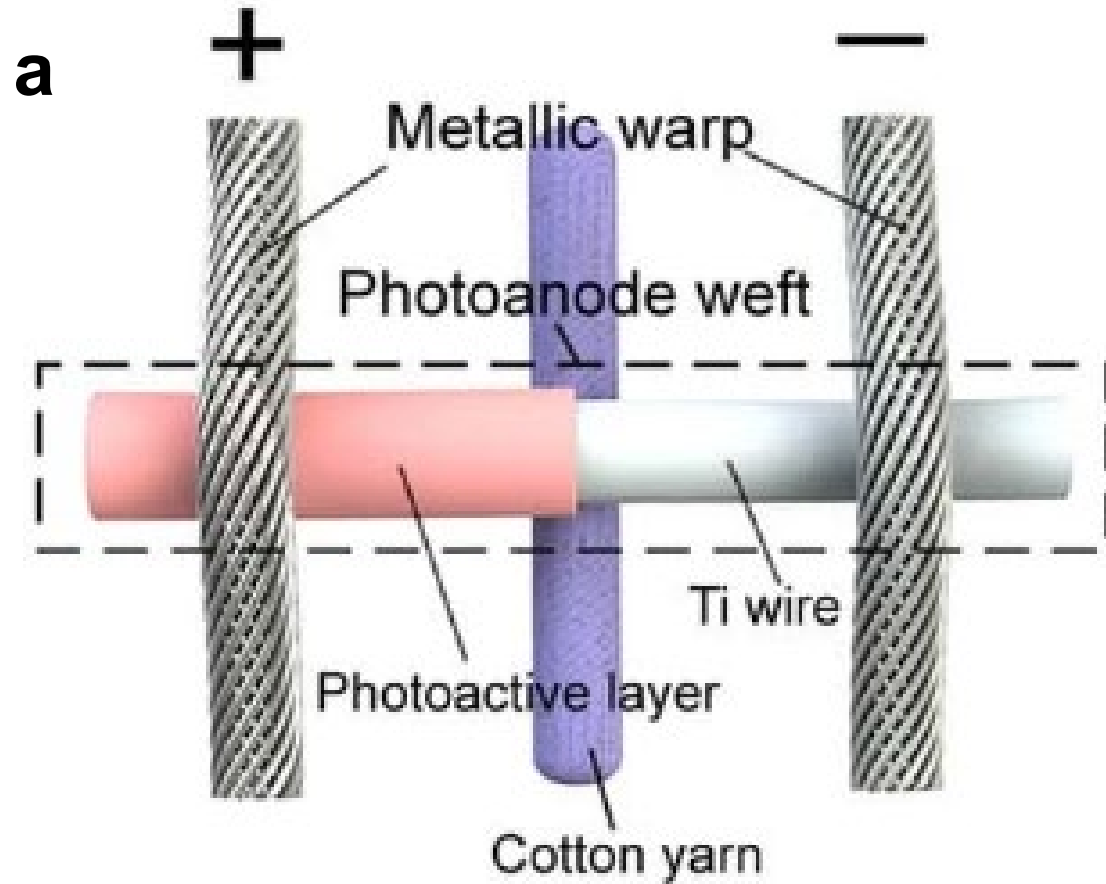
Art Statement - Textile Keyboard



e, Working mechanism of the textile keyboard.
f, Voltages (V_s) recorded by pressing individual keys one by one. The correspondence between the key position and its characteristic V_s are indicated by the coordinates in b and f.

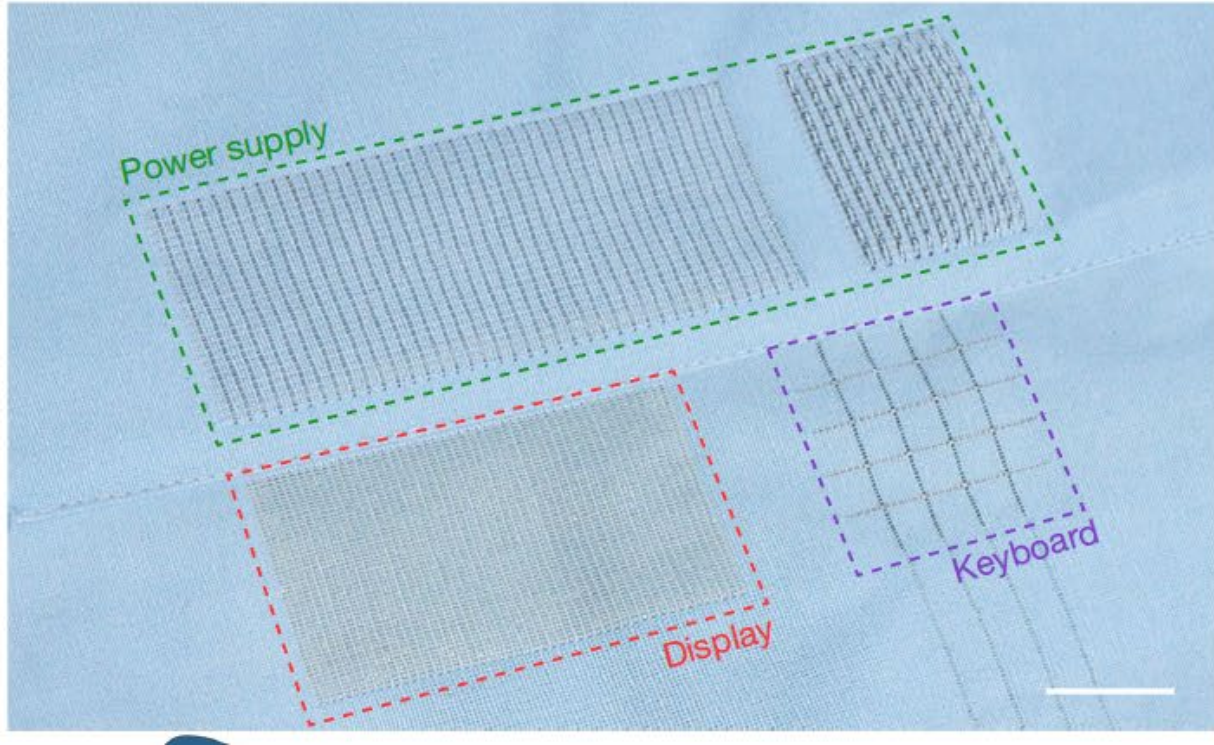


Art Statement - Textile Power Supply System.

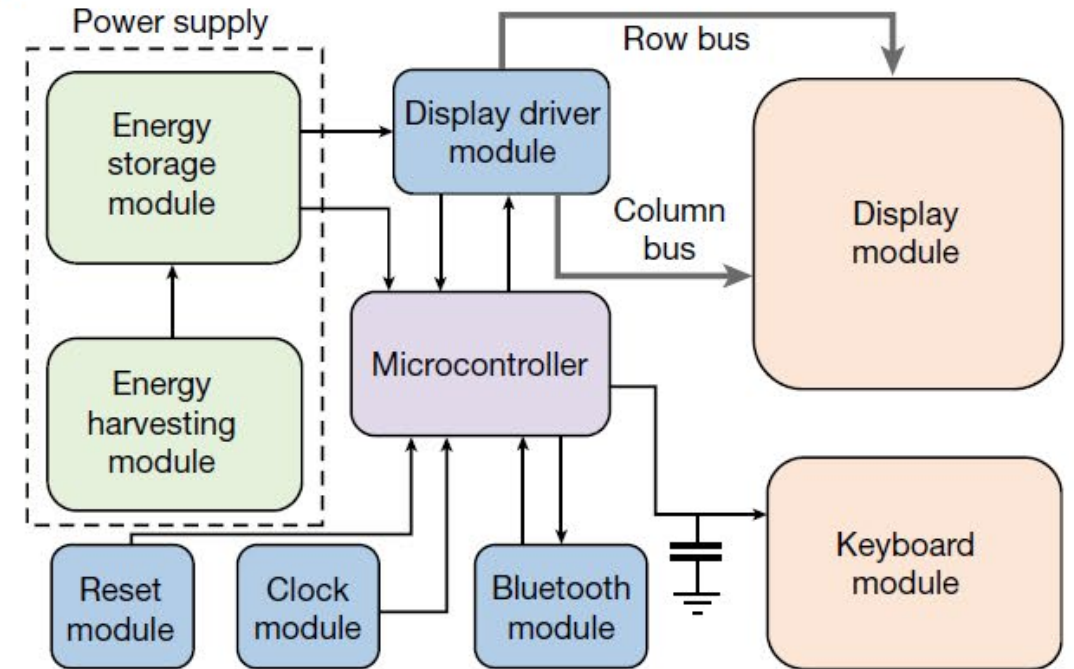


Art Statement - Integrated Textile Systems

a



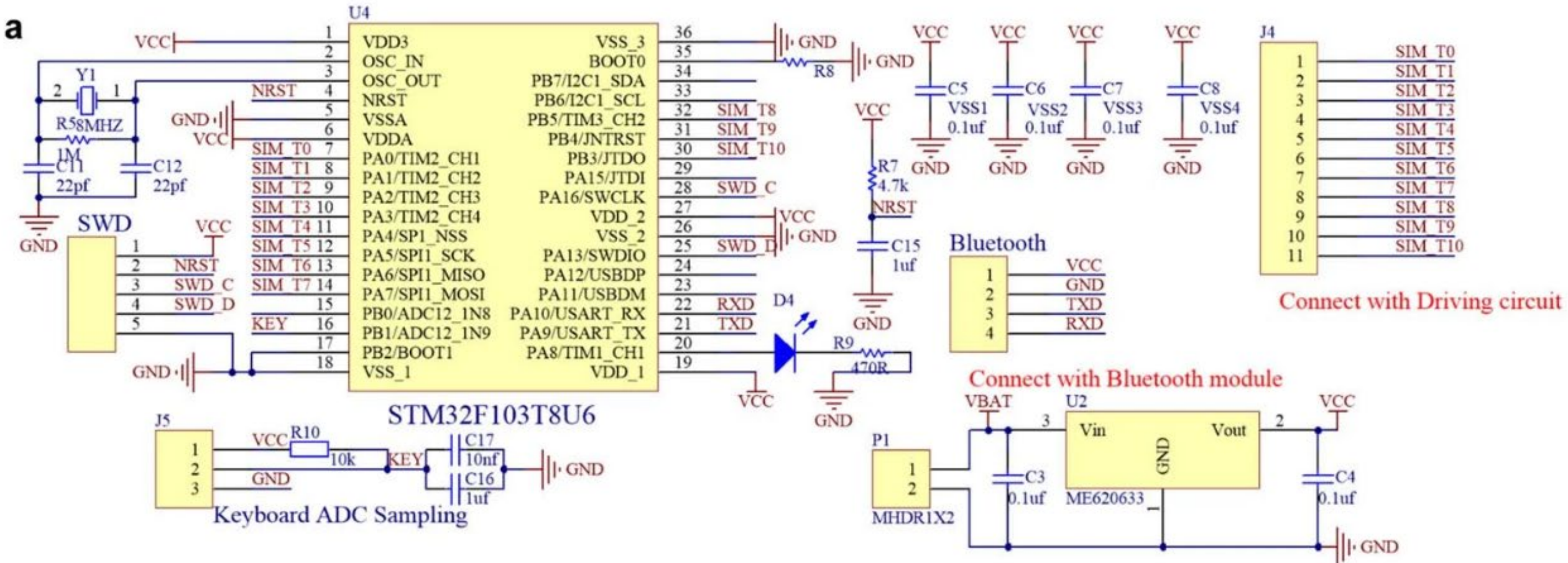
b



a, Photograph of an integrated textile system consisting of display, information input (keyboard) and power supply modules. Scale bar, 2 cm.

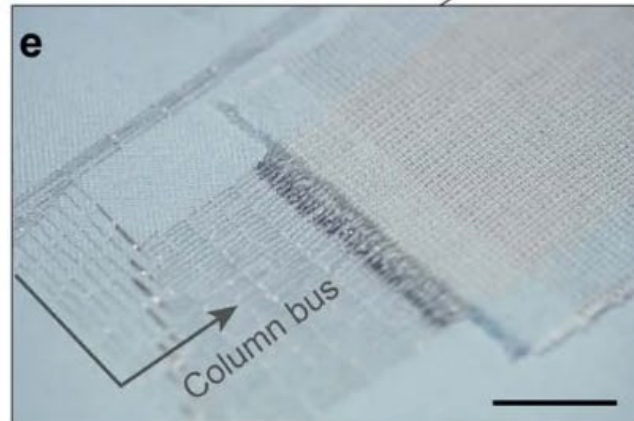
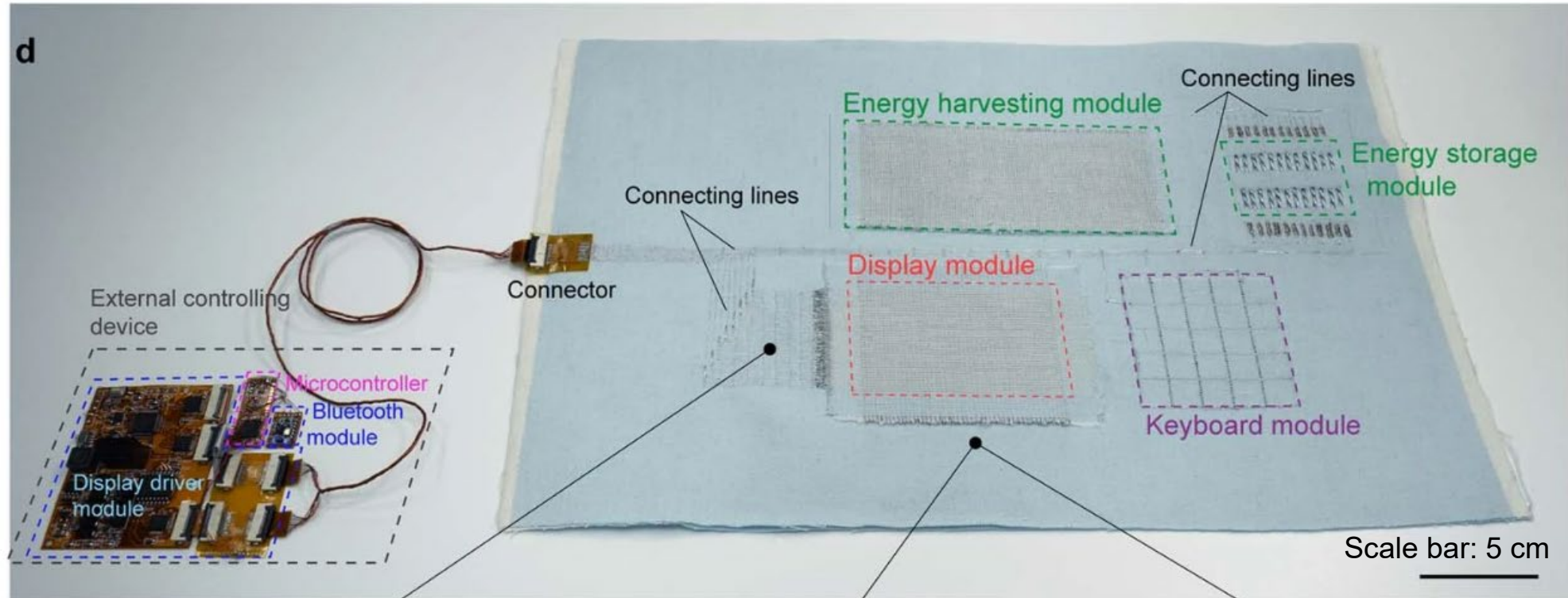
b, System-level block diagram of the integrated textile system in a shows the modules connected to a microcontroller that is powered by solar-energy harvesting and electrical energy storage modules.

Art Statement - Integrated Textile Systems

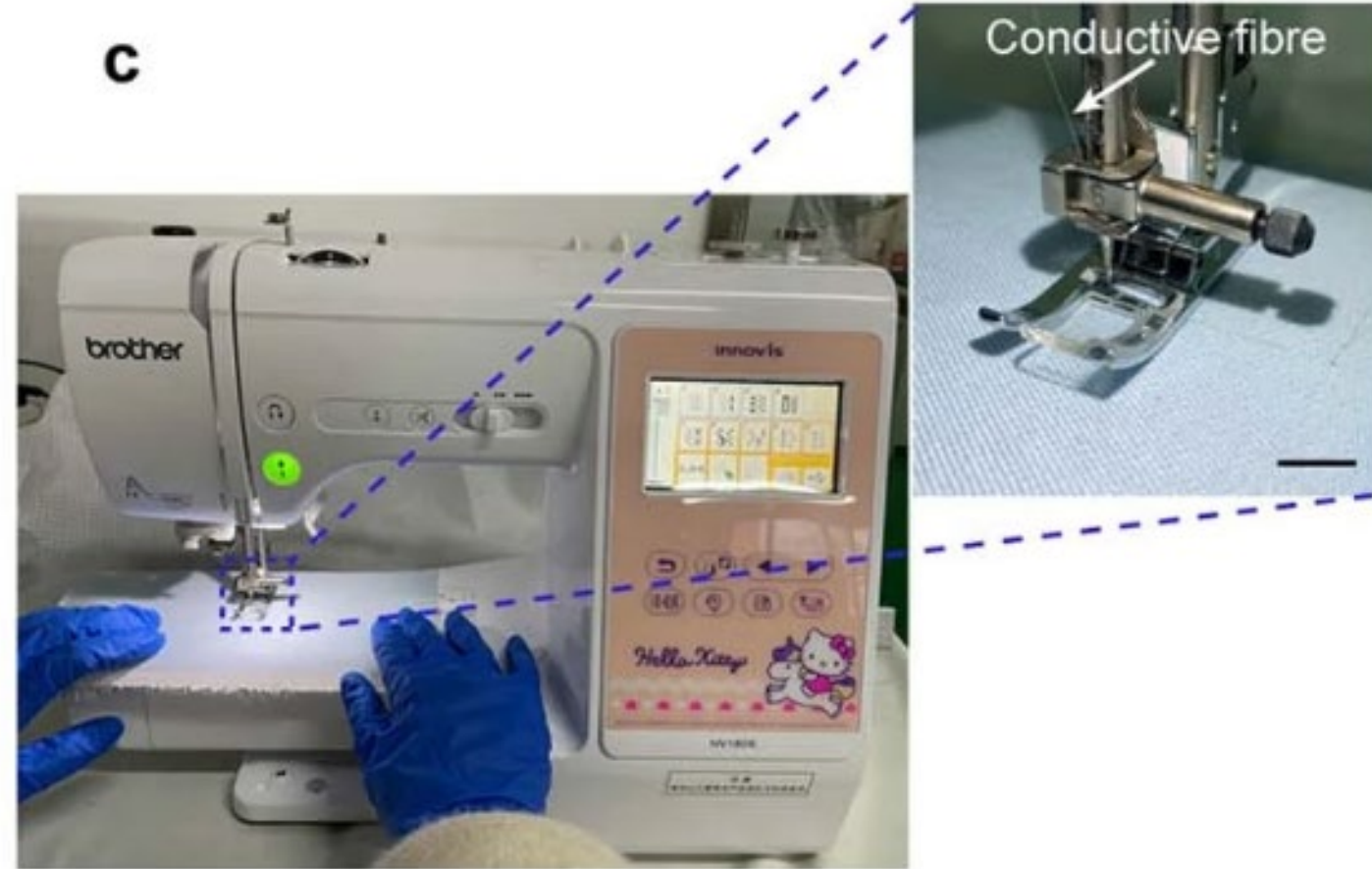
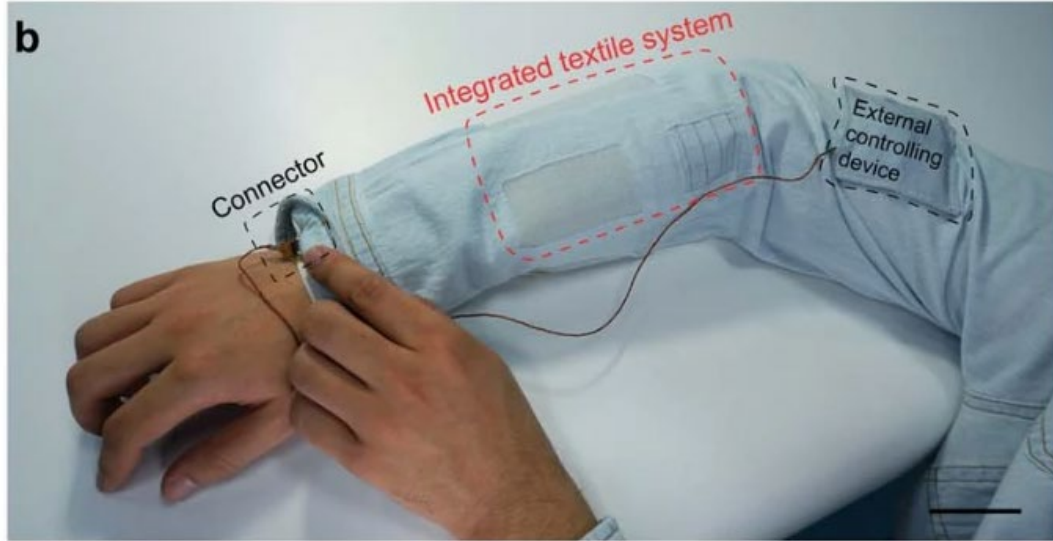


a, Schematic of the circuit design for the integrated textile system.

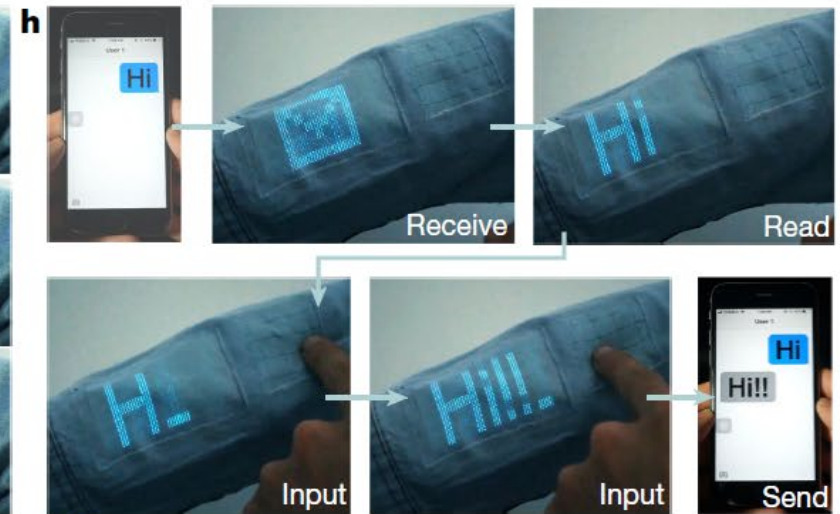
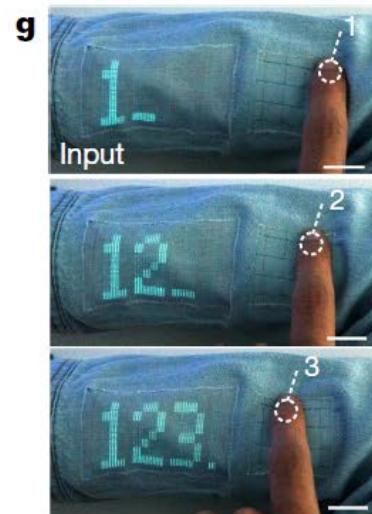
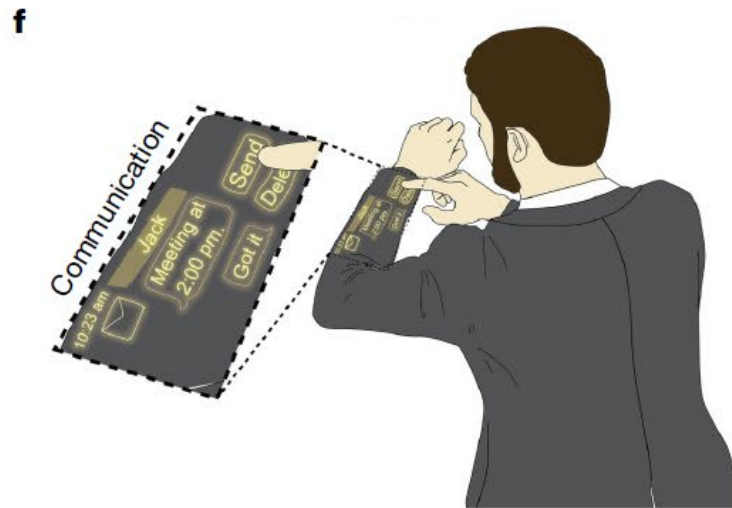
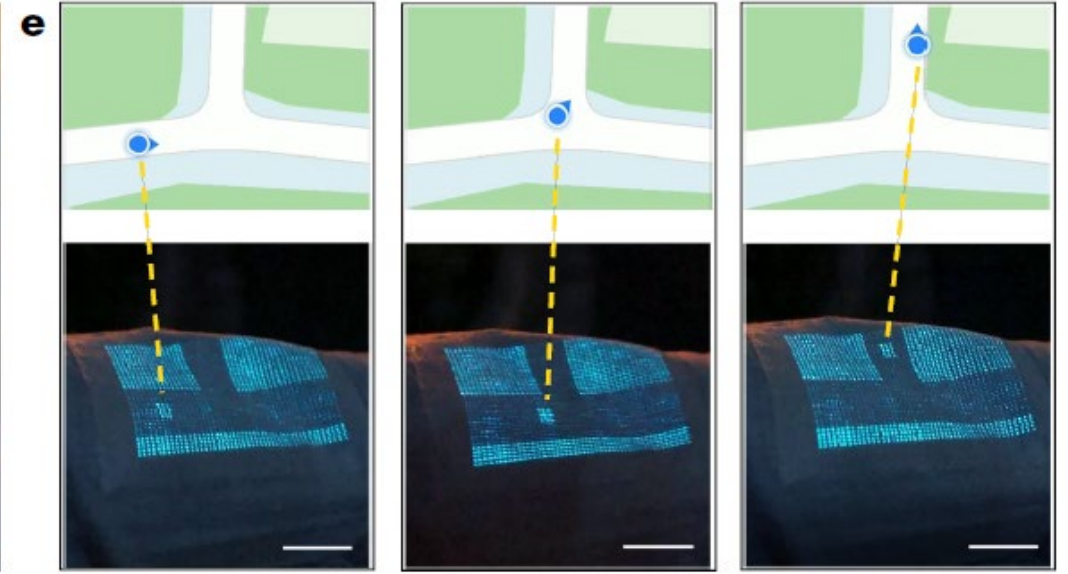
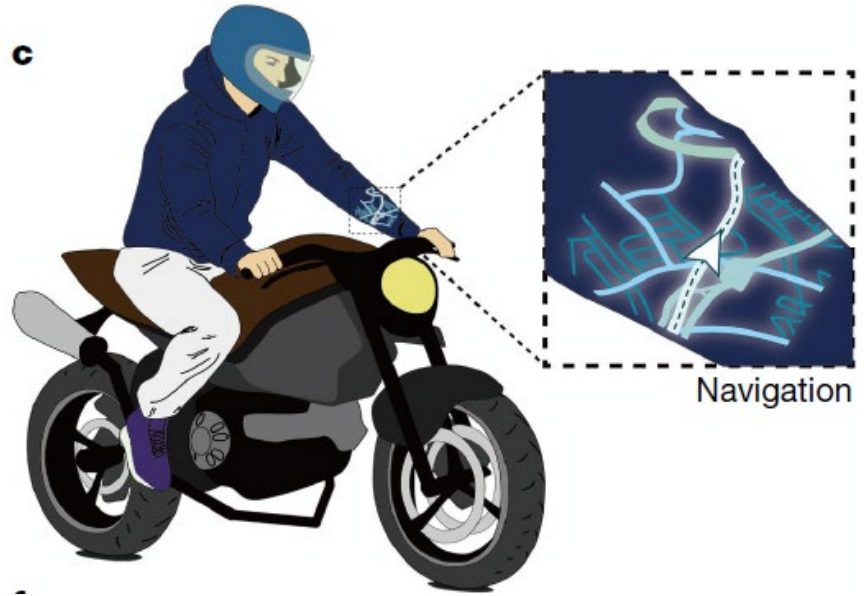
Art Statement - Integrated Textile Systems



Art Statement - Integrated Textile Systems



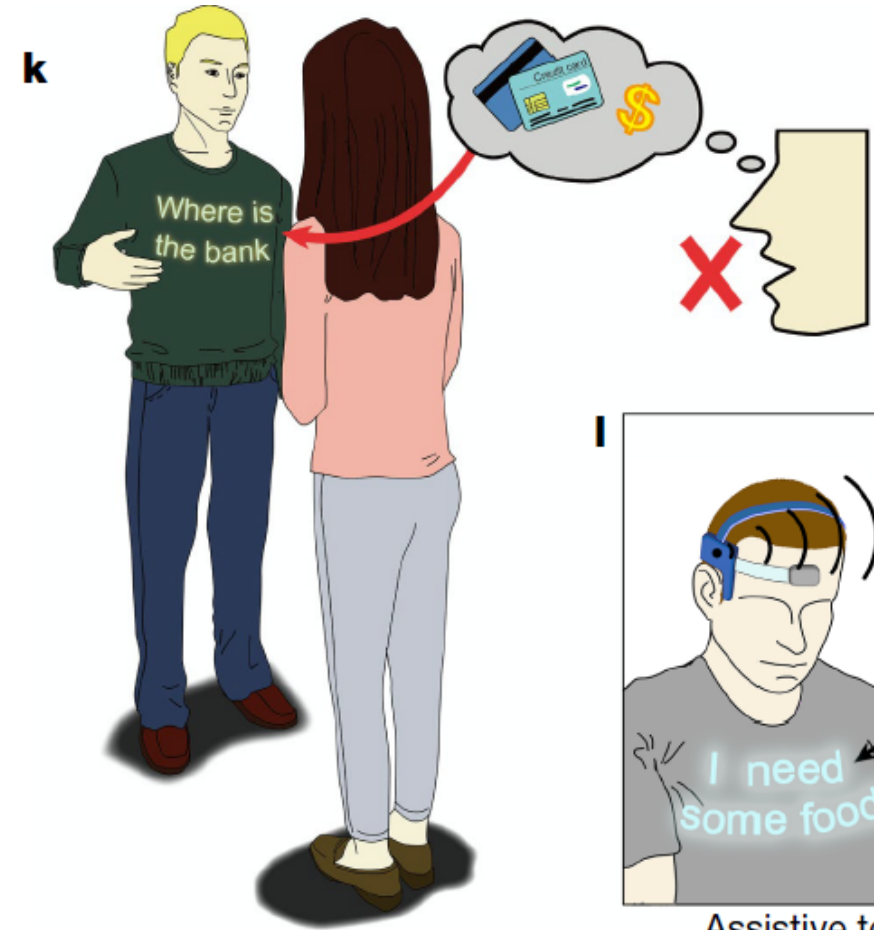
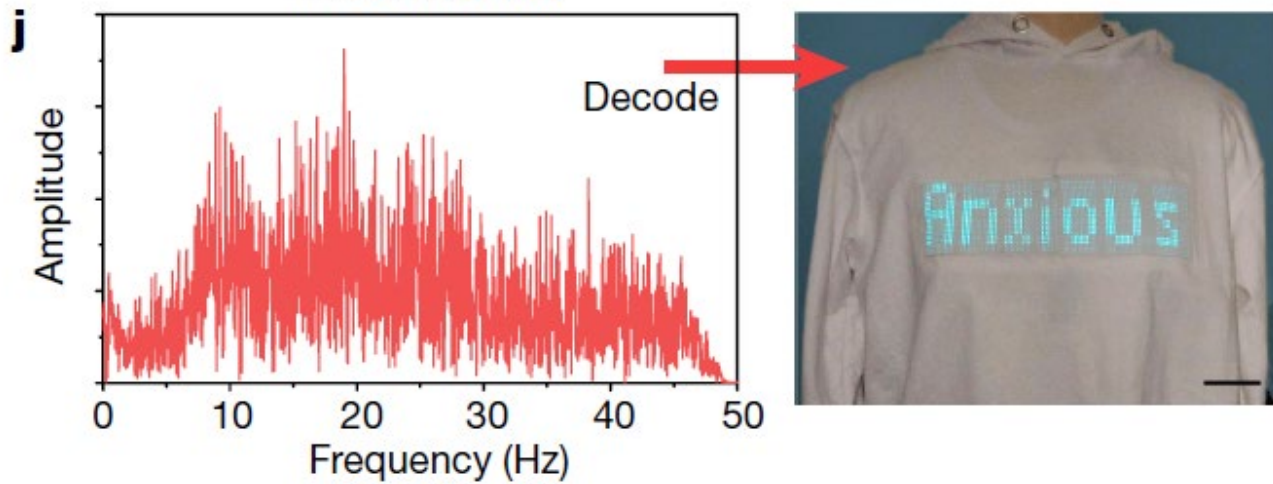
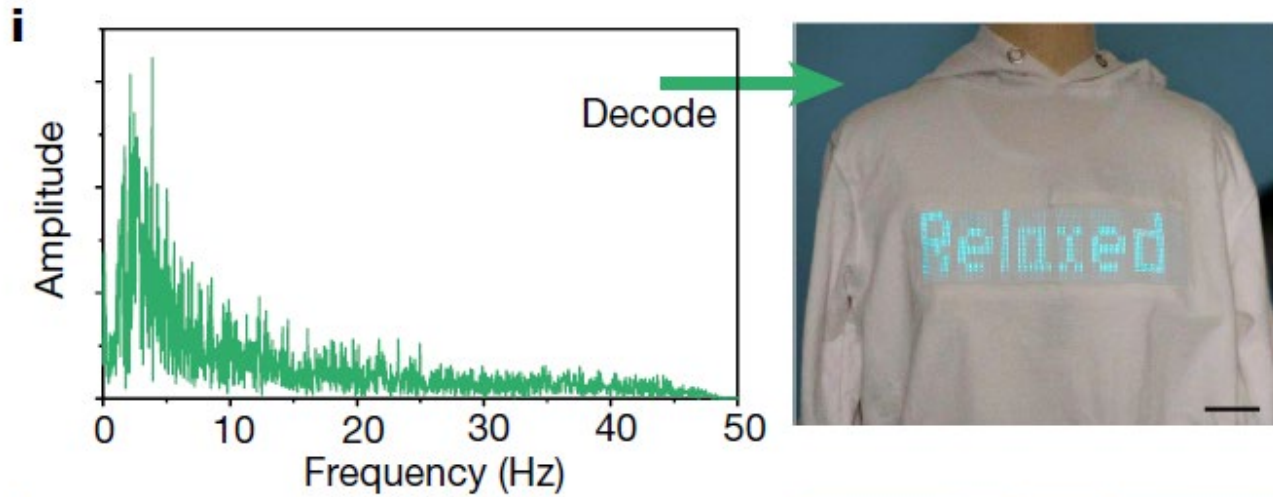
Art Statement - Integrated Textile Systems



Art Statement - Integrated Textile Systems



Art Statement - Integrated Textile Systems



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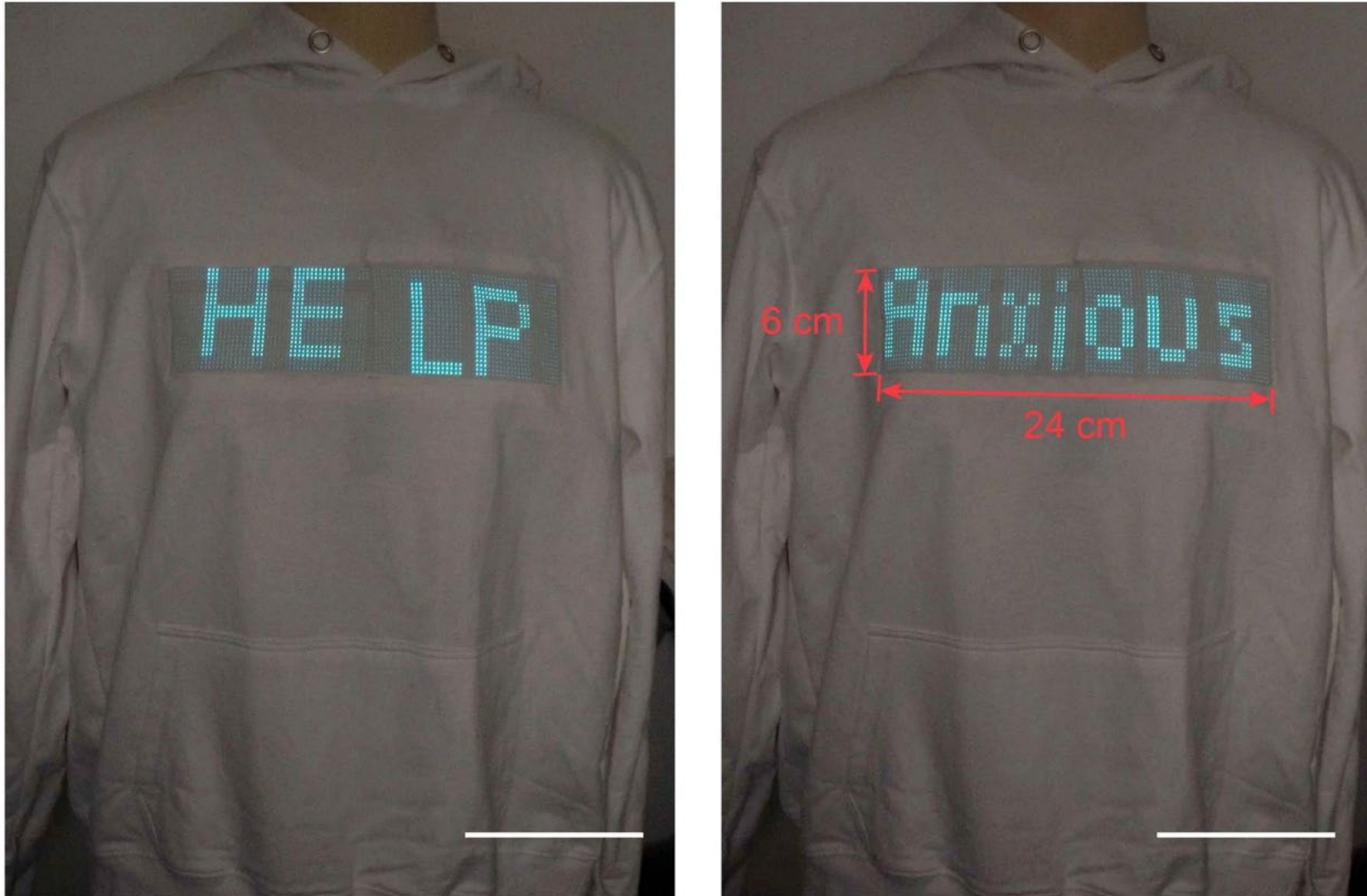
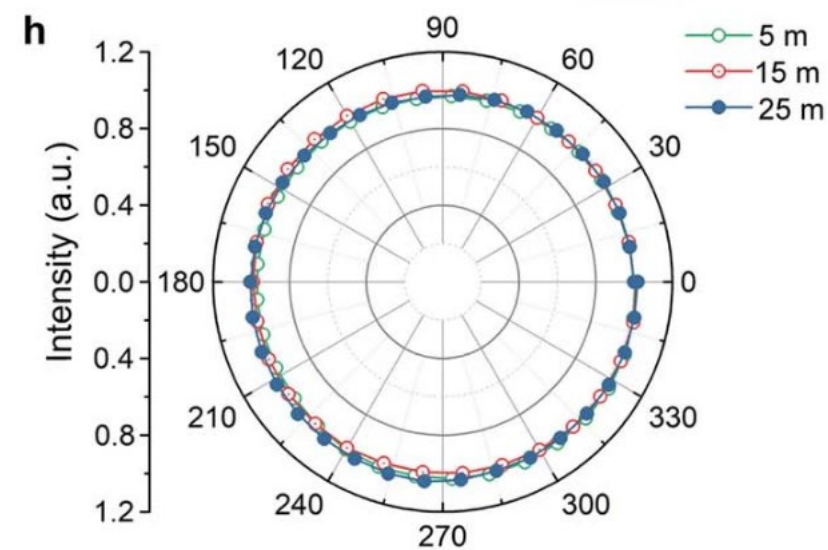
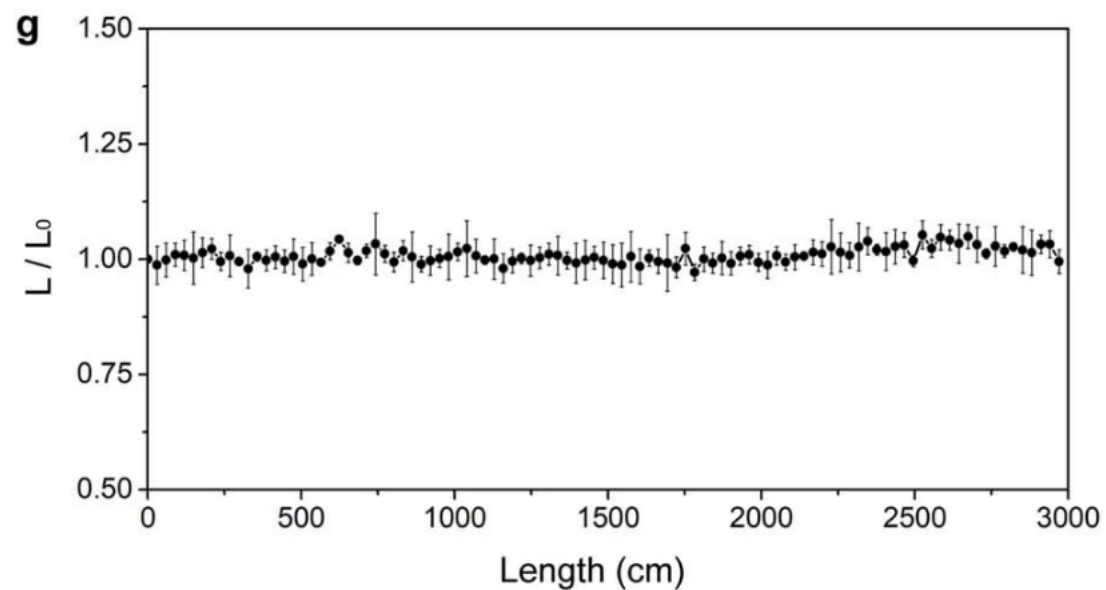
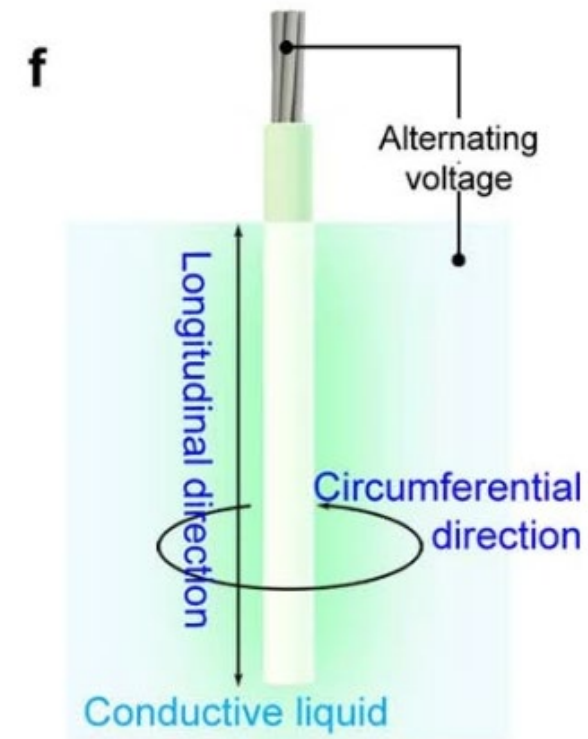
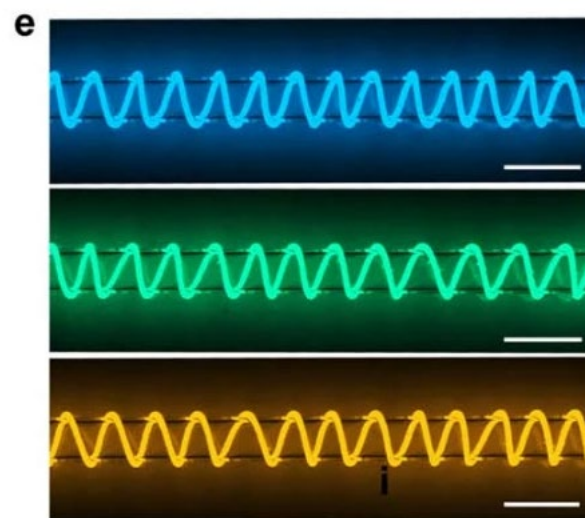
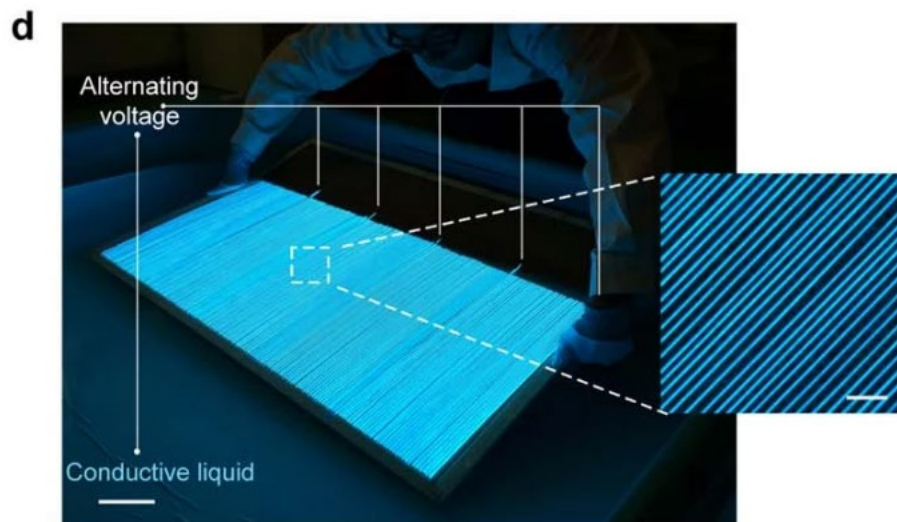
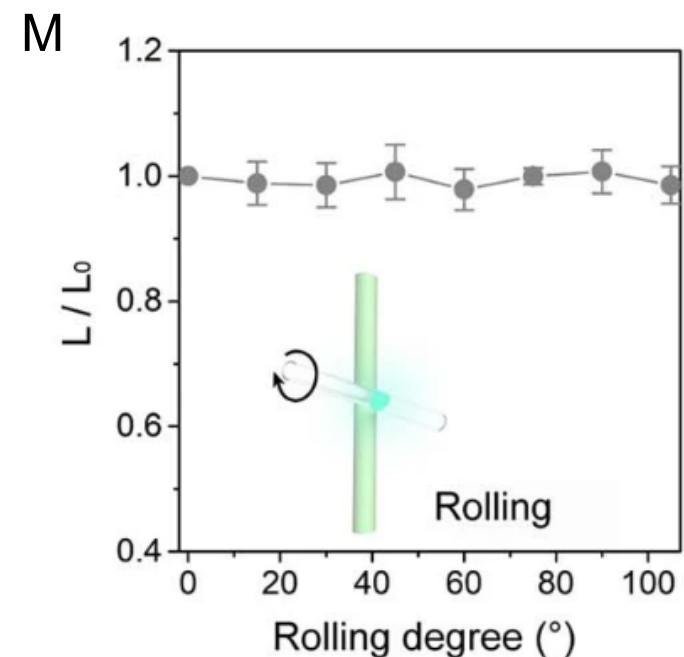
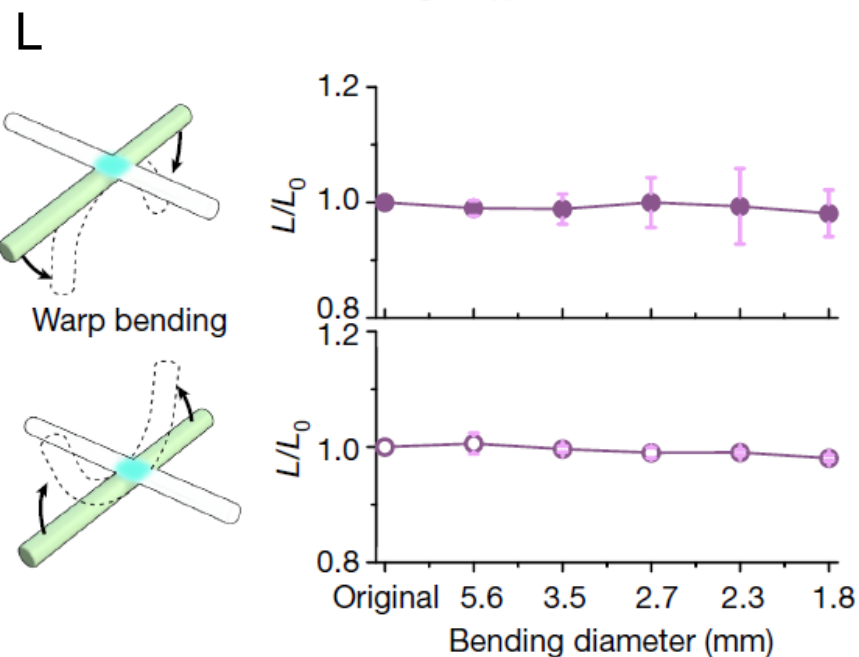
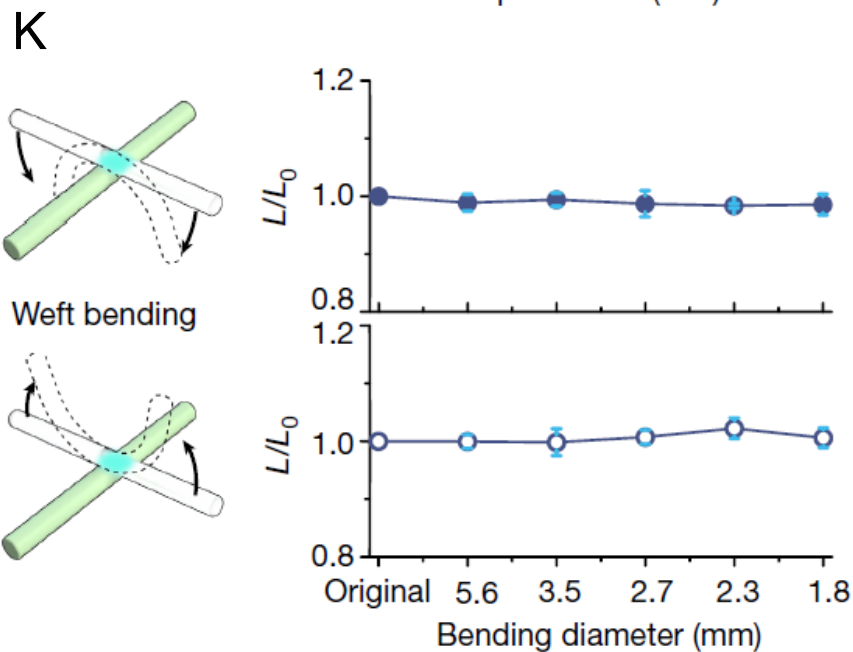
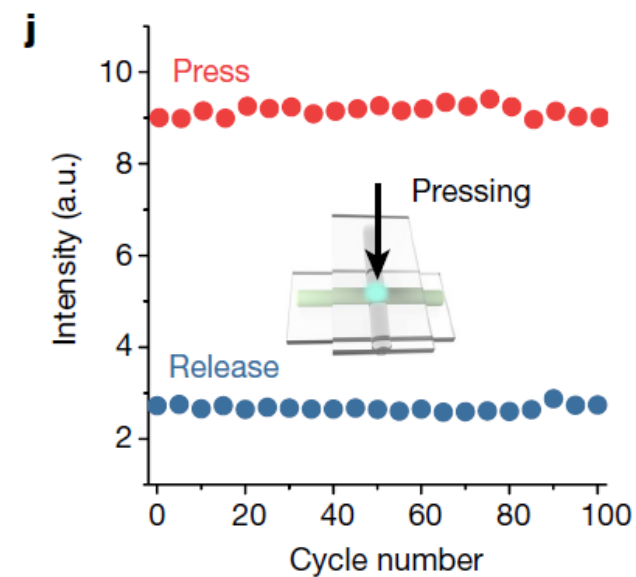
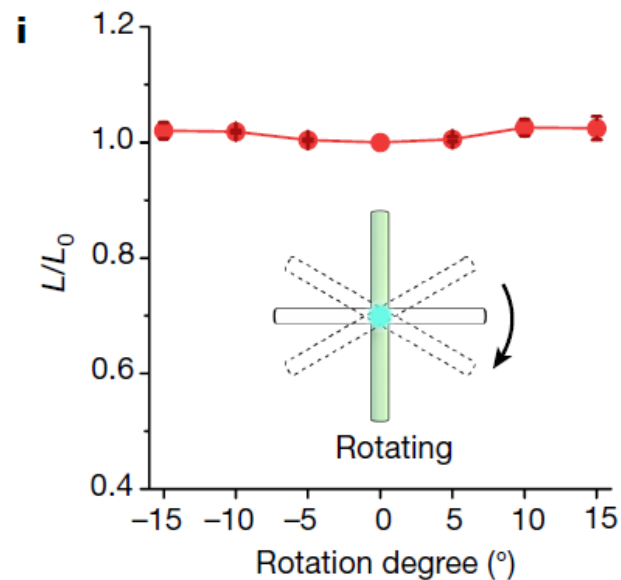
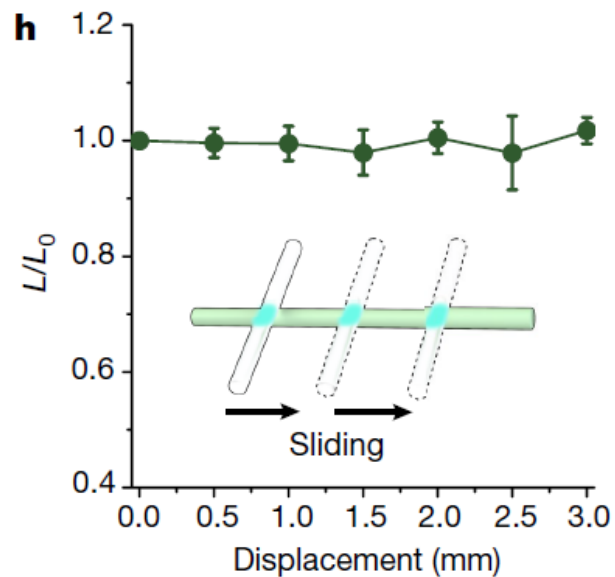


Fig. A large display textile measuring 24 cm × 6 cm (length × width).

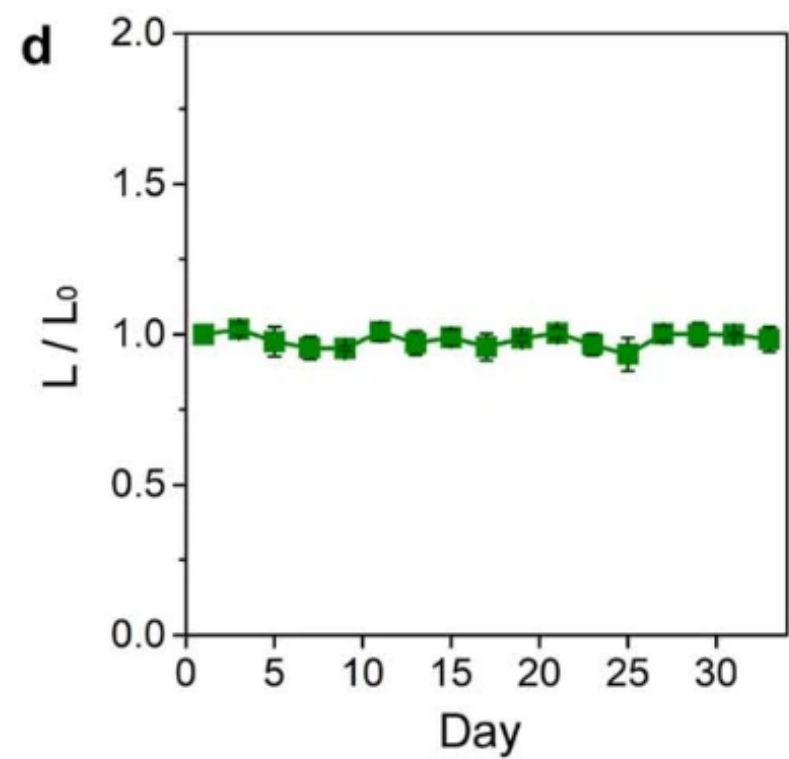
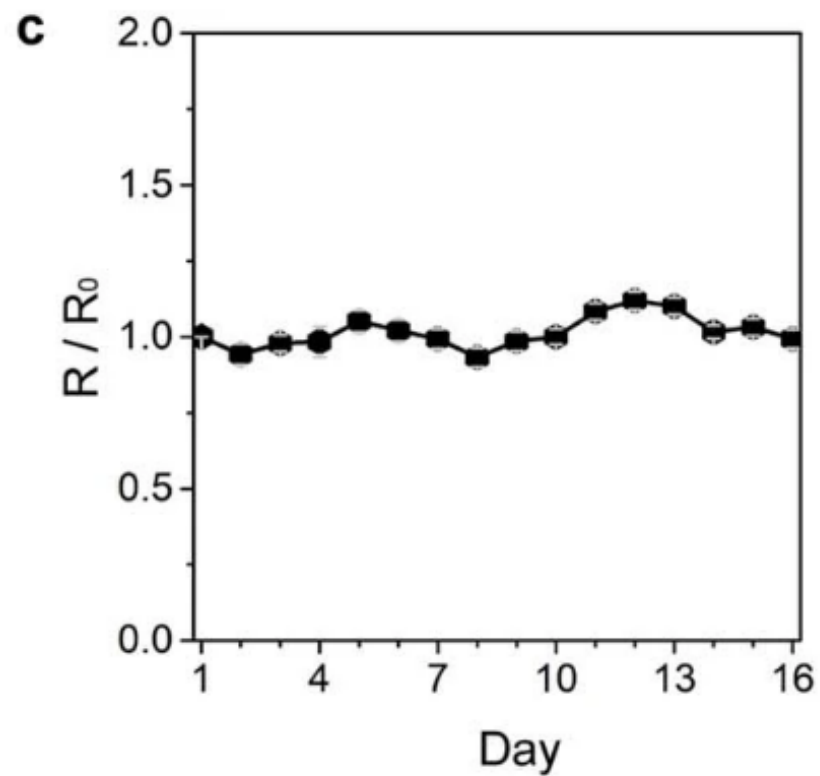
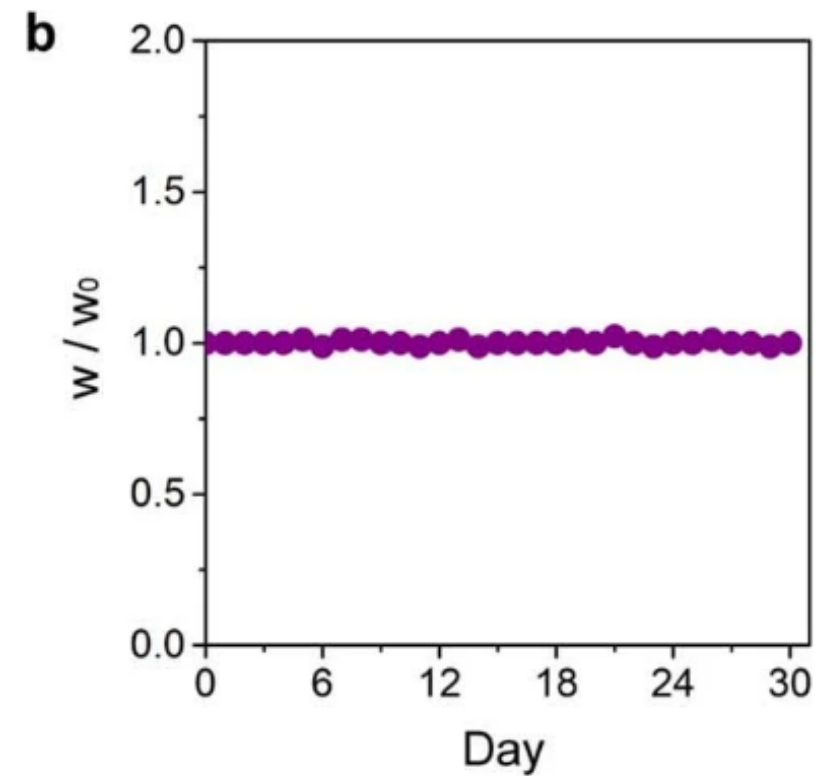
Experiment Results - Reliability



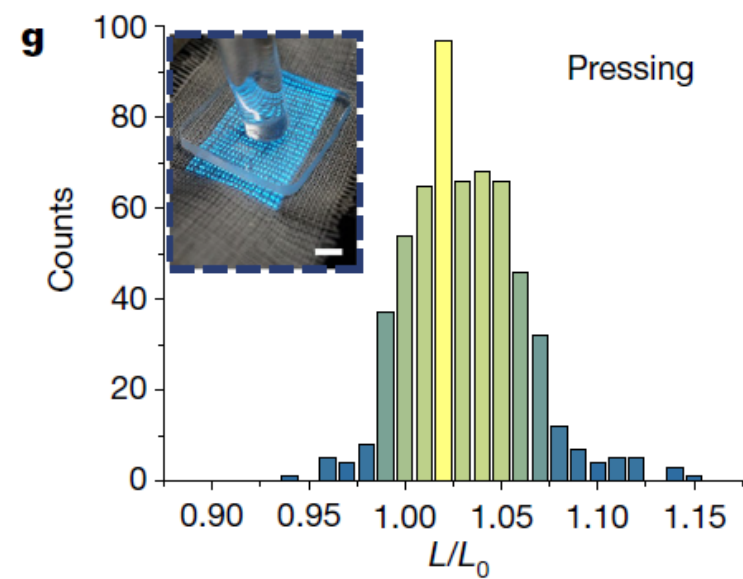
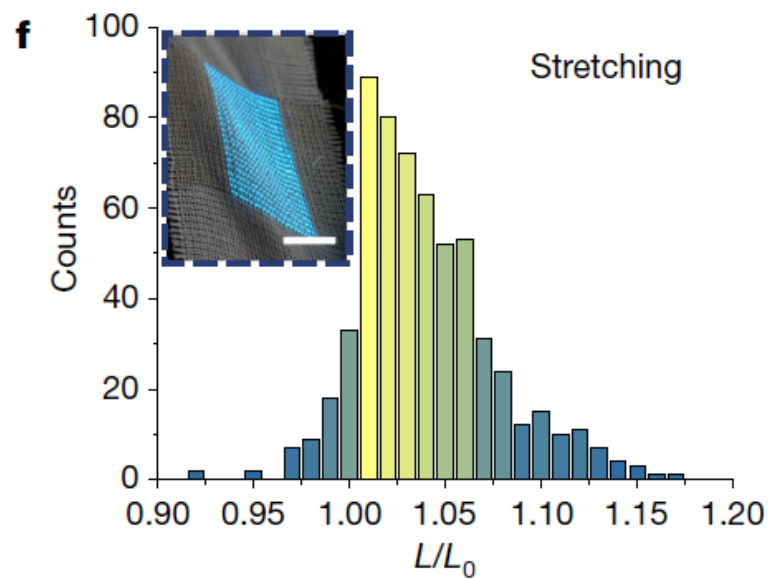
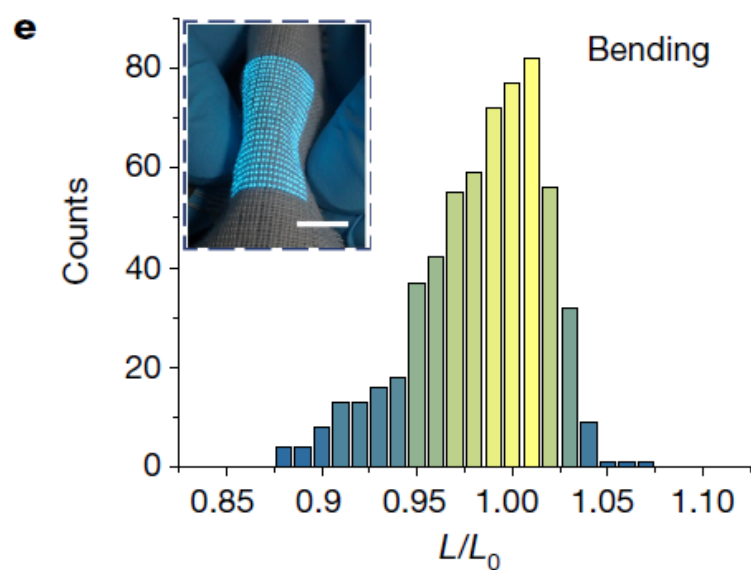
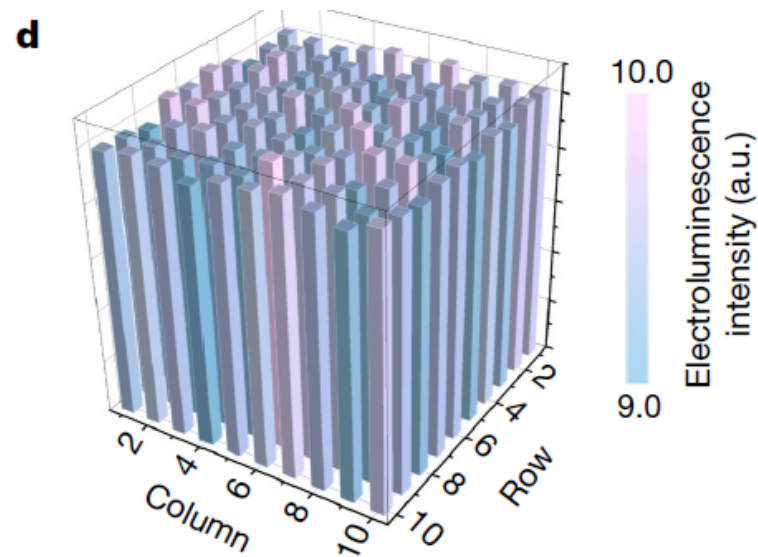
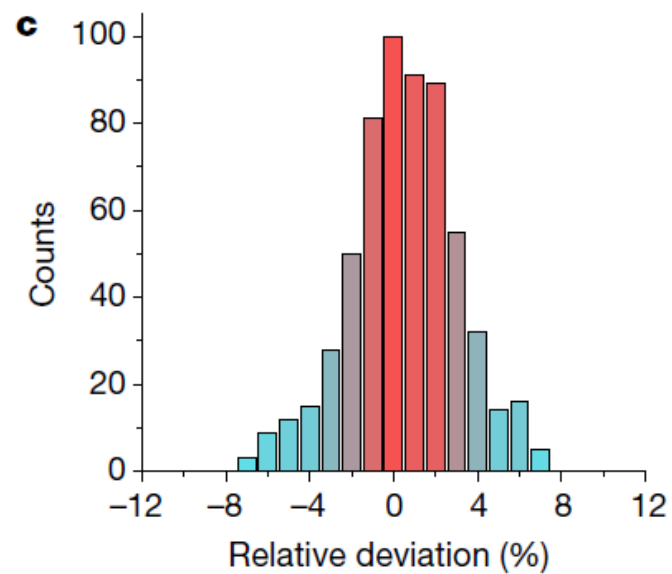
Experiment Results - Reliability



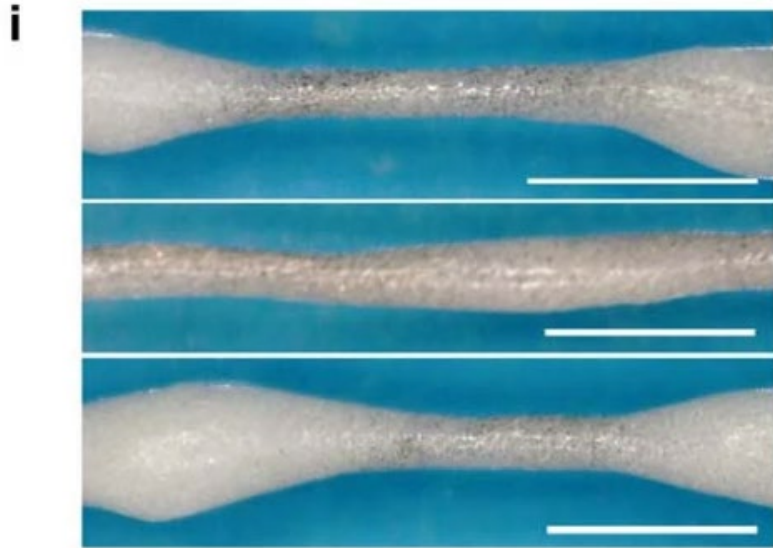
Experiment Results - Reliability



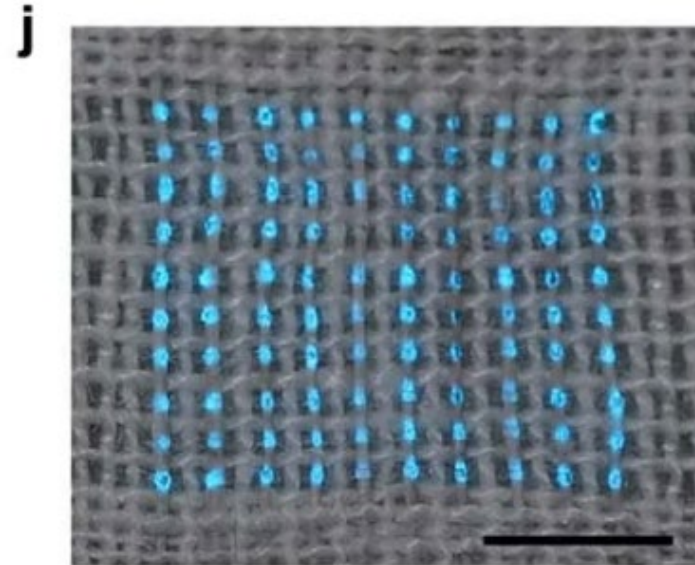
Experiment Results - Reliability



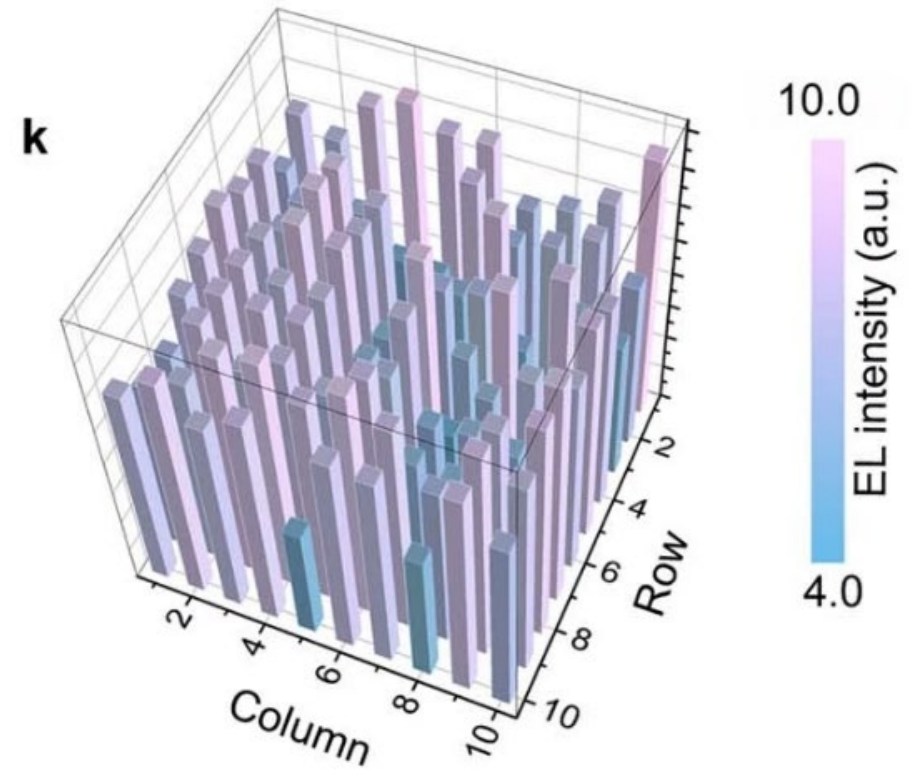
Experiment Results - Reliability



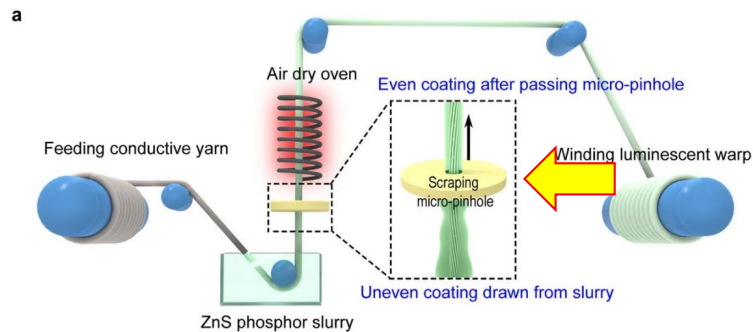
i, Uneven luminescent layer in the case without using the scraping micro-pinhole. Scale bars, 1 mm.



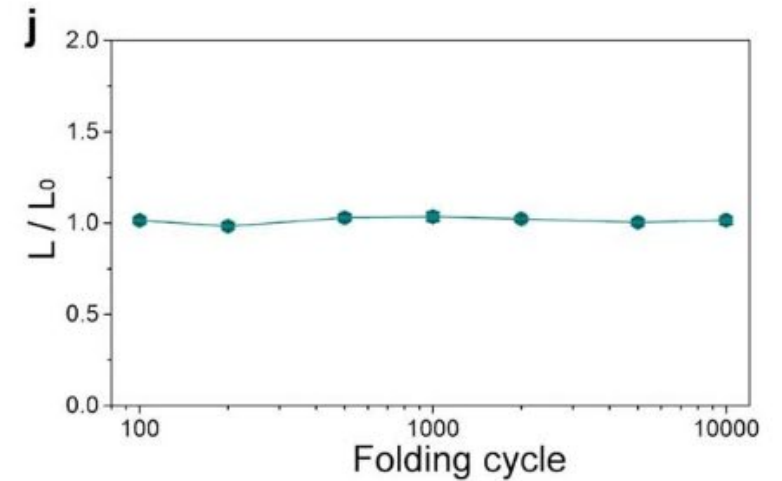
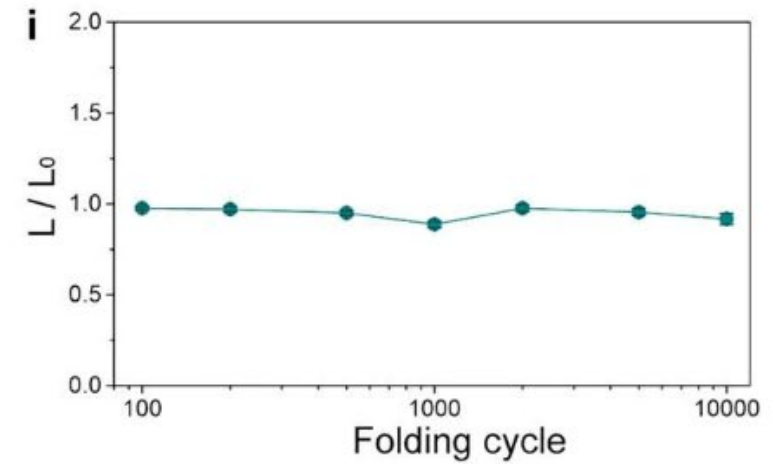
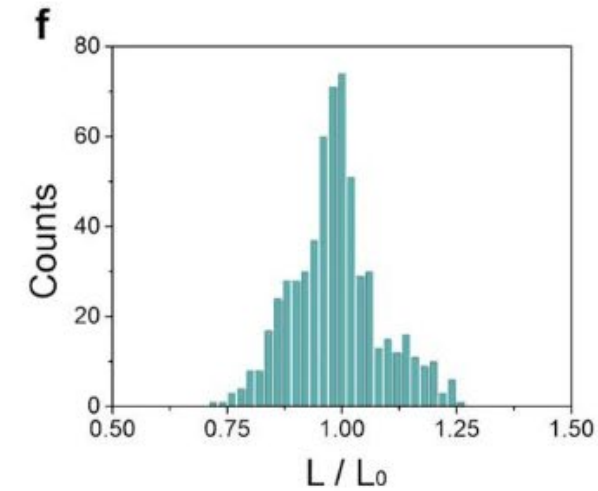
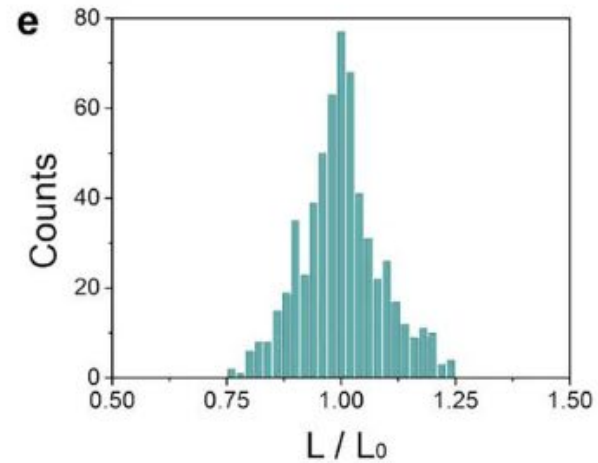
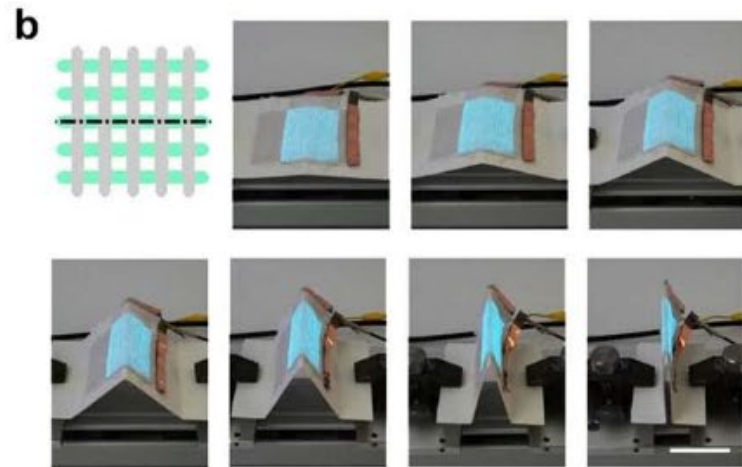
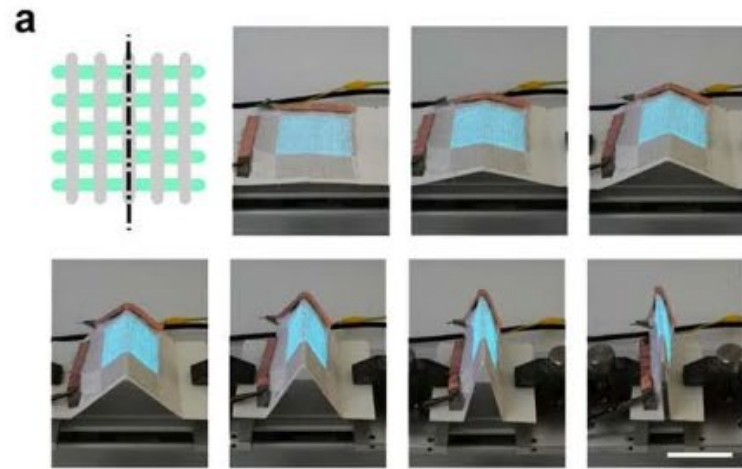
j, Photograph of the display textile woven from luminescent warps with uneven coating. Scale bar, 5 mm.



k, Relative emission intensities of the 10 × 10 EL unit array in j.

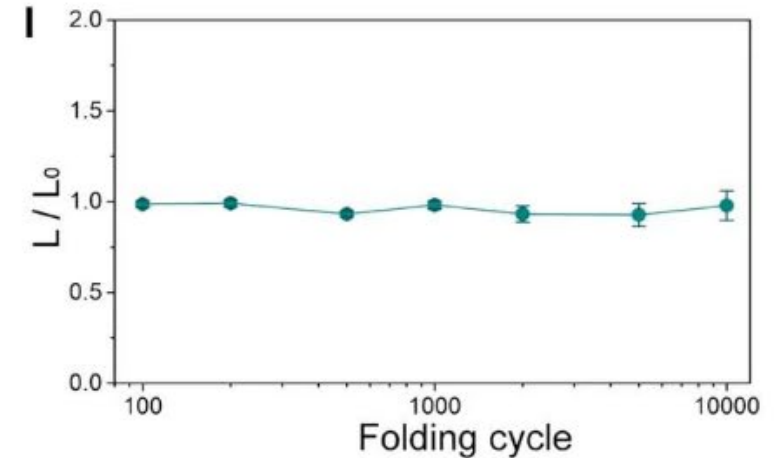
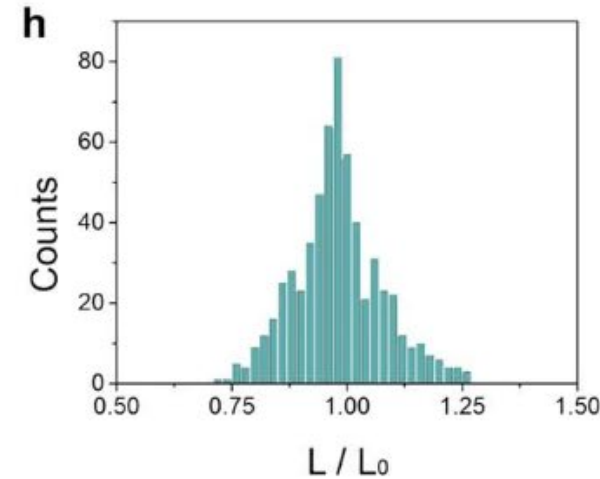
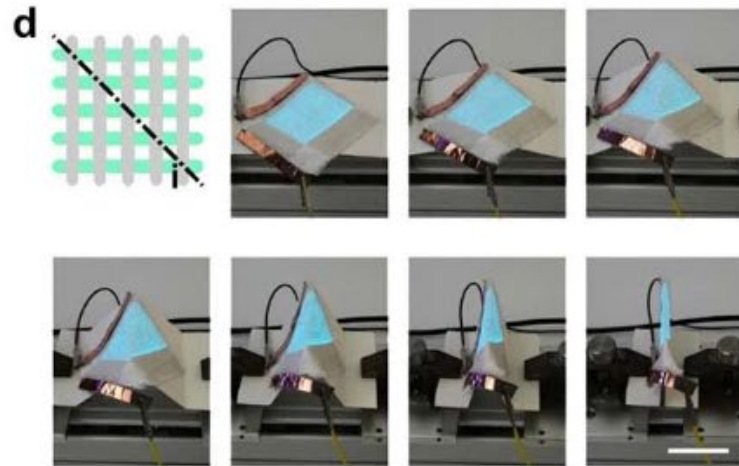
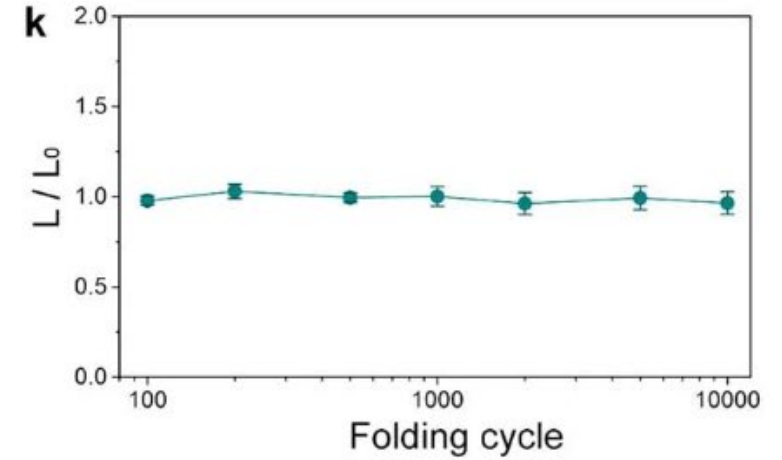
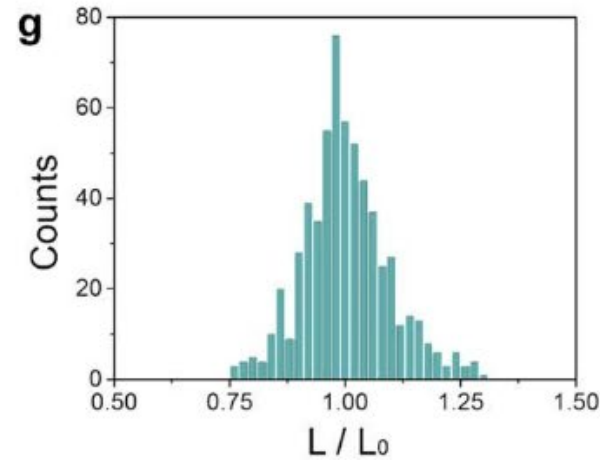
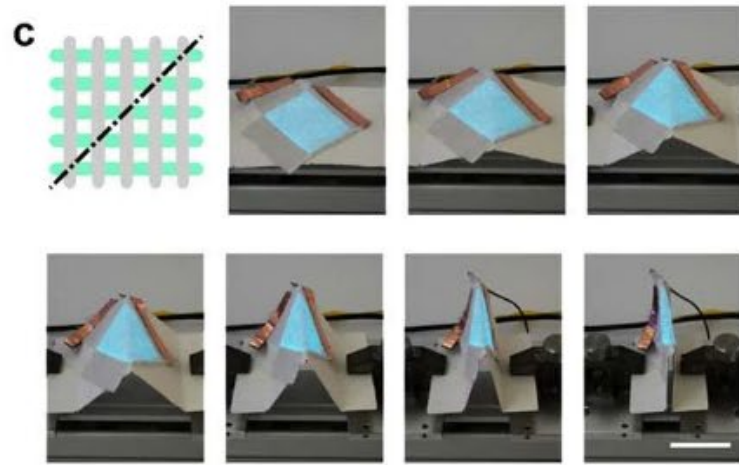


Experiment Results - Reliability



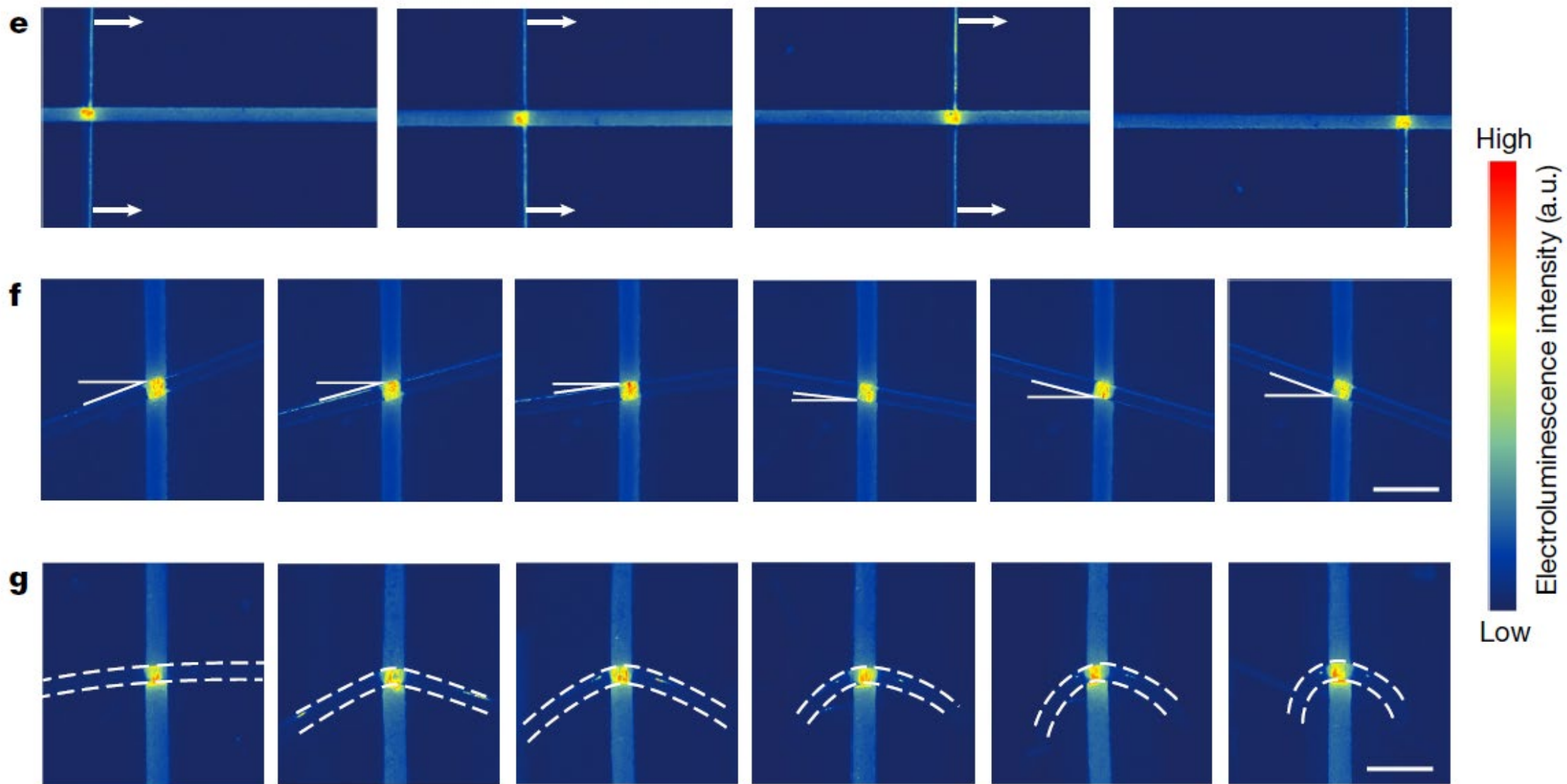
a–l, Photographs (a–d), statistical distribution of variations in luminance of EL units of a display textile containing 600 EL units (e–h), and variation of the relative luminescent intensity for the EL units at the folding lines (i–l) when the textile was successively folded along the vertical middle line (a, e, i), horizontal middle line (b, f, j) and diagonal lines (c, g, k, d, h, l) for 10,000 cycles each. The bending radius was 1 mm. The majority of the EL units showed little change. Scale bars, 5 cm. Error bars are standard deviations of the results from six samples.

Experiment Results - Reliability



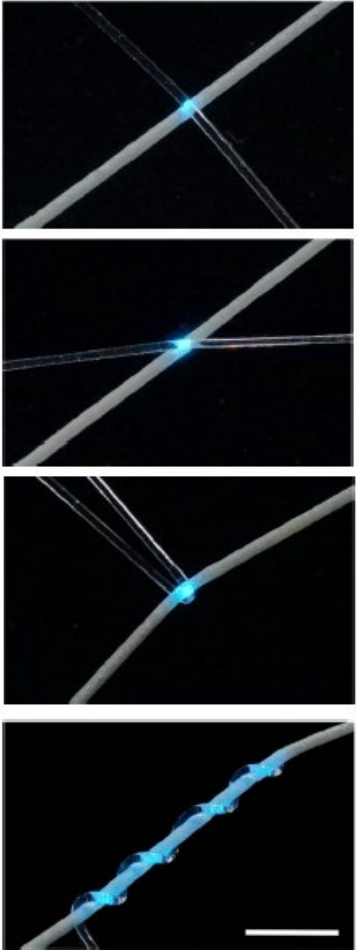
a–l, Photographs (a–d), statistical distribution of variations in luminance of EL units of a display textile containing 600 EL units (e–h), and variation of the relative luminescent intensity for the EL units at the folding lines (i–l) when the textile was successively folded along the vertical middle line (a, e, i), horizontal middle line (b, f, j) and diagonal lines (c, g, k, d, h, l) for 10,000 cycles each. The bending radius was 1 mm. The majority of the EL units showed little change. Scale bars, 5 cm. Error bars are standard deviations of the results from six samples.

Experiment Results - Reliability



Experiment Results - Reliability

d

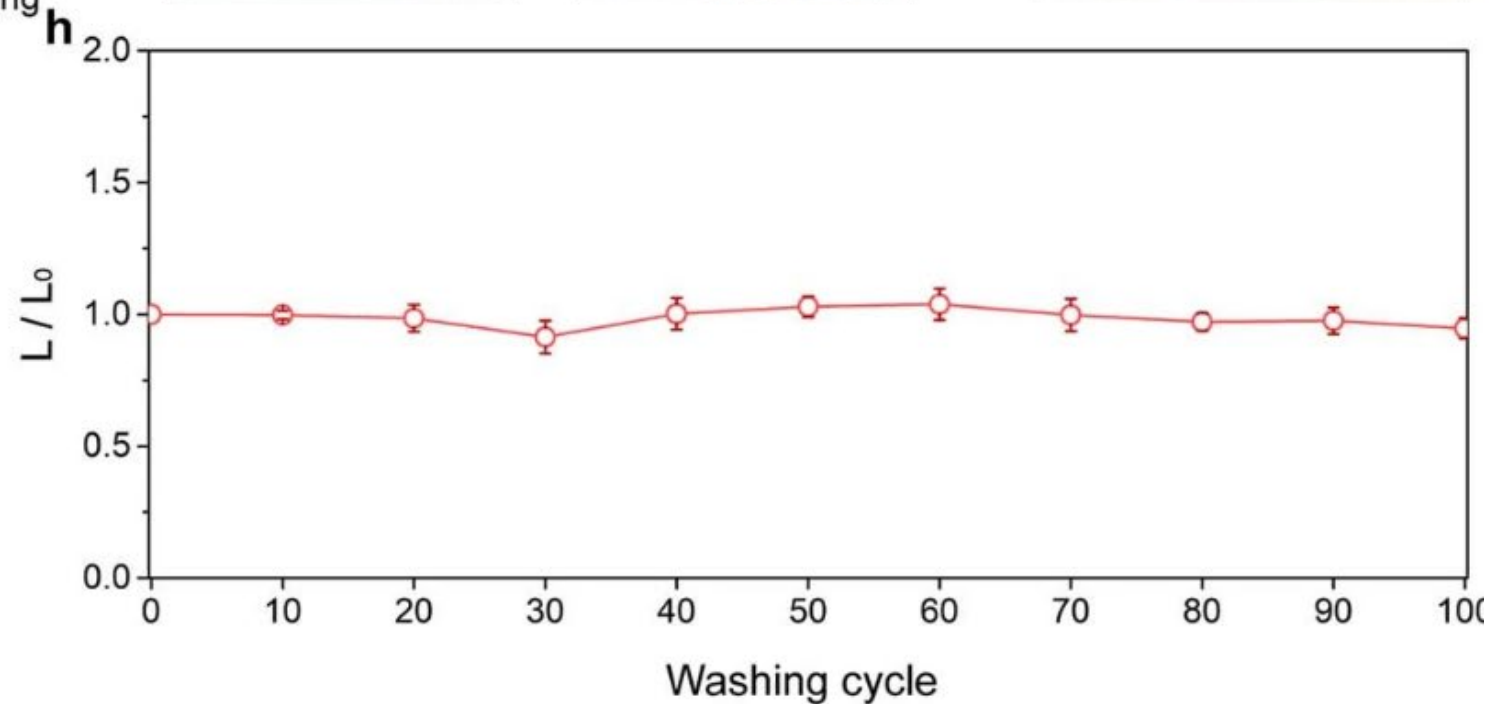
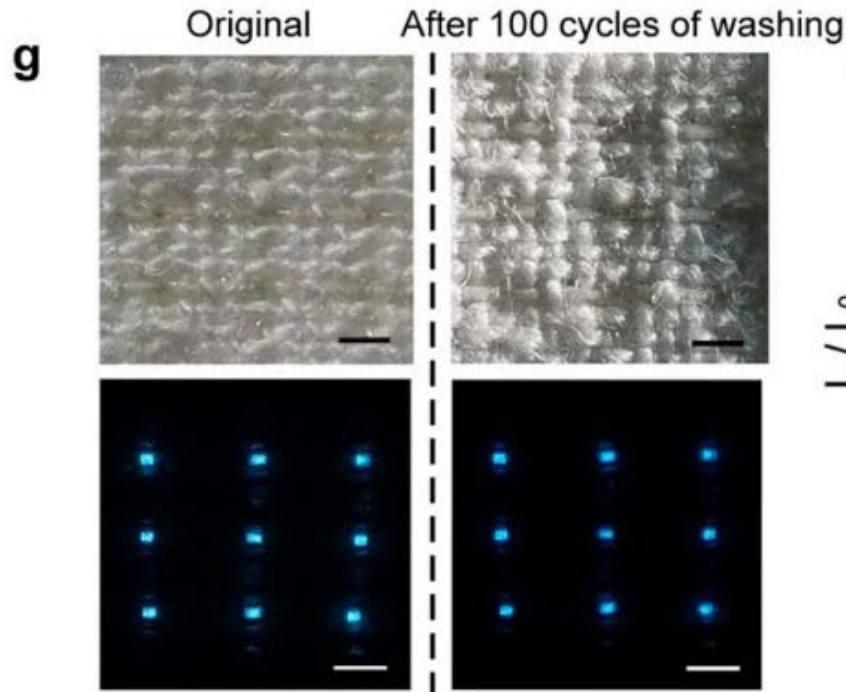
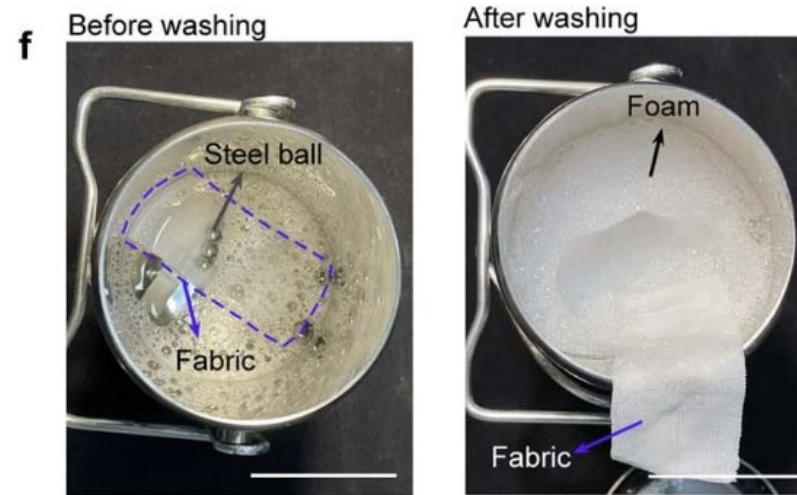


Scale bar: 2 mm

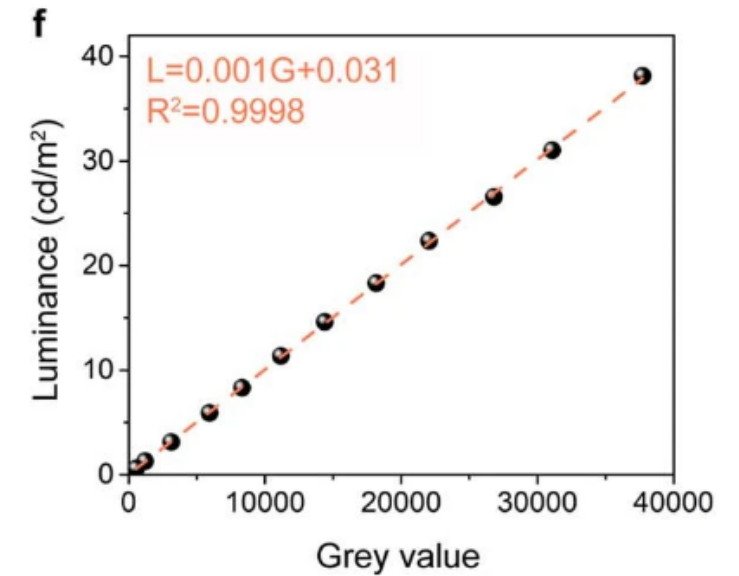
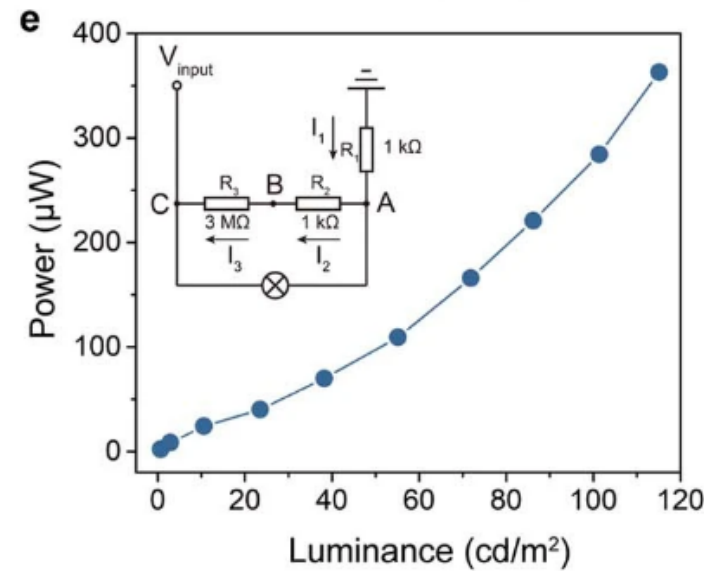
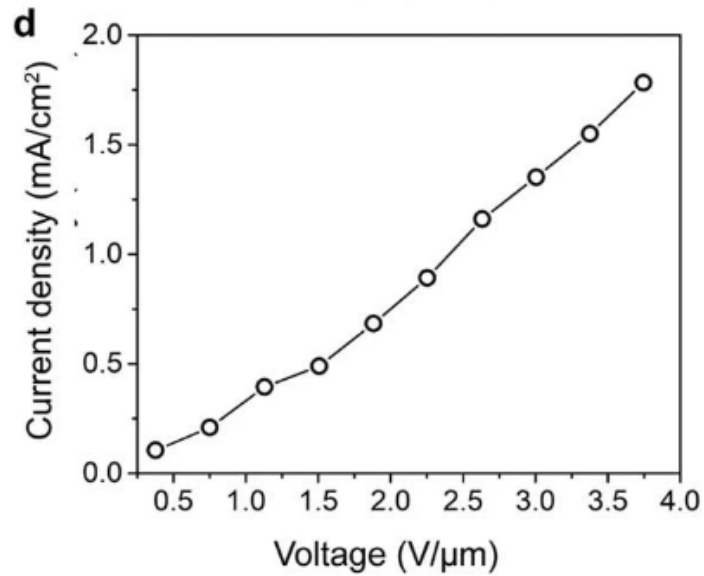
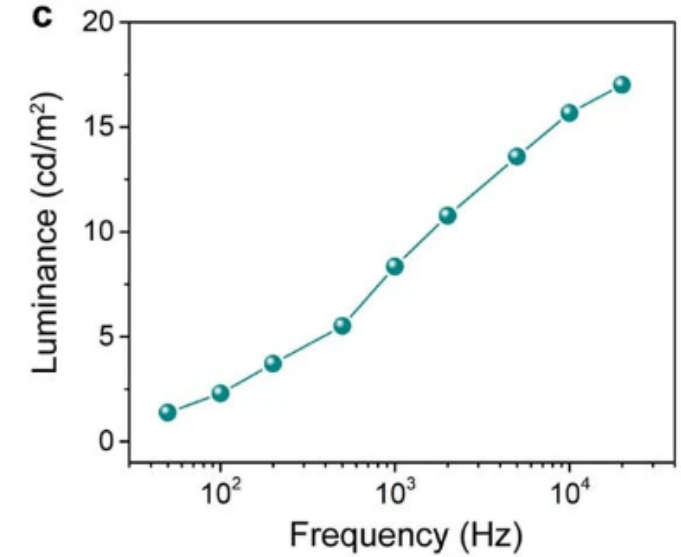
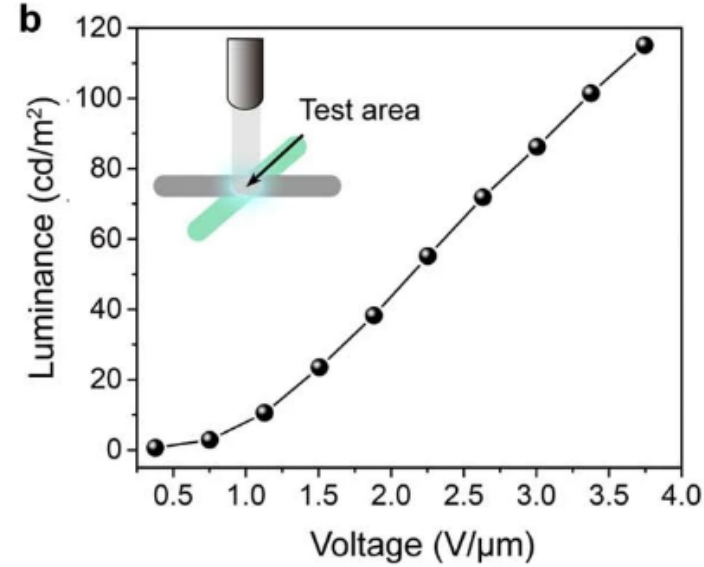
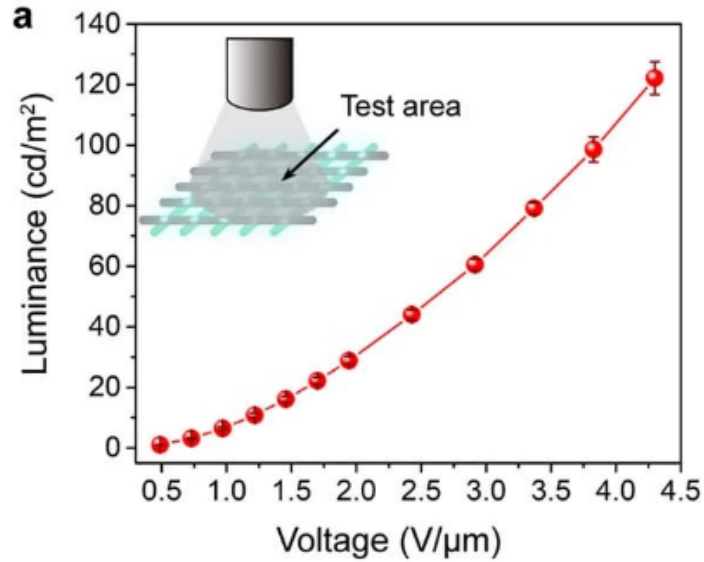


Experiment Results - Reliability

- Durability of polyurethane ionic gel fibre and EL units.

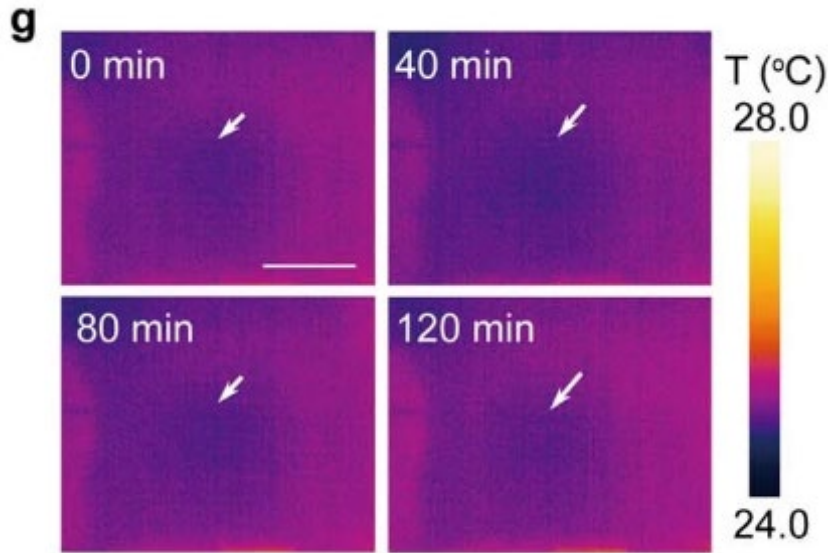
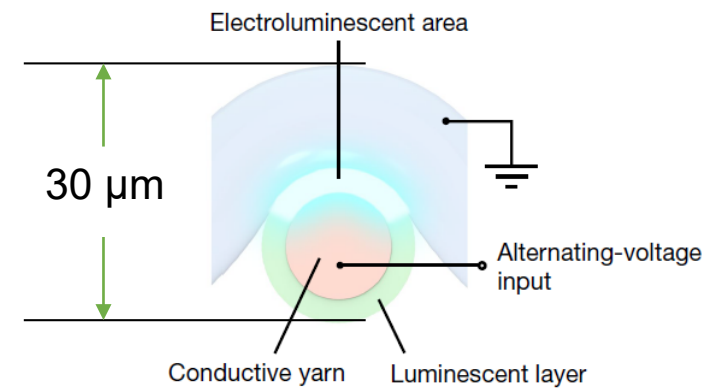


Experiment Results - Efficacy

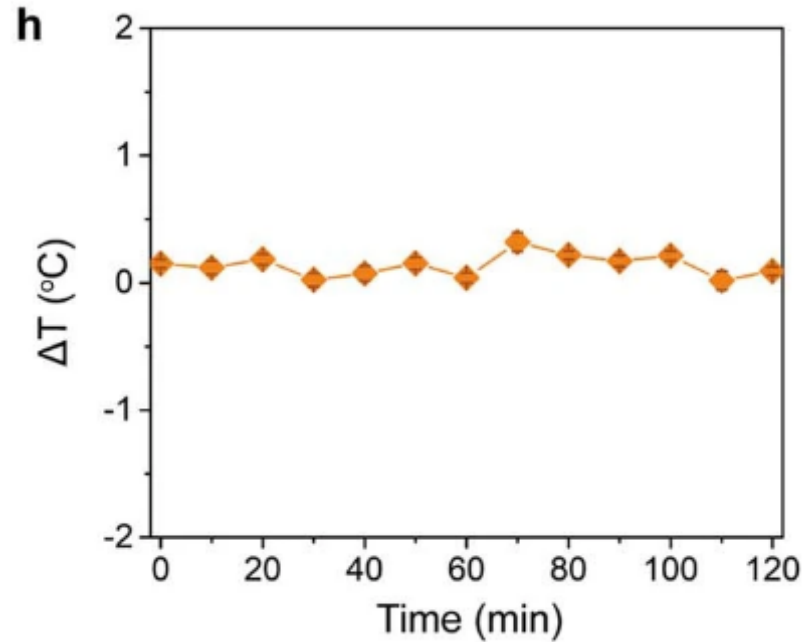


Electroluminescence performance of the display textile and EL unit.

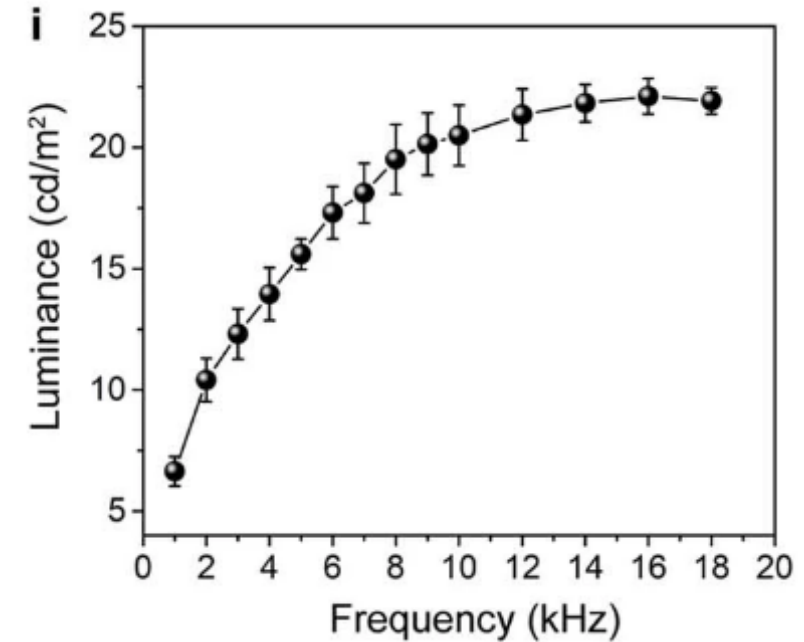
Experiment Results - Efficacy



g, Thermal images of an EL unit illuminated for increasing durations (under a power of $\sim 300 \mu\text{W}$). The arrows indicate the position of the EL unit. Scale bar, 5 mm.



h, Local temperature variations of EL units under a power of $\sim 300 \mu\text{W}$.



i, Luminance–frequency curve of the EL unit working at 35 V. Thickness of the luminescent layer is $\sim 30 \mu\text{m}$. Error bars represent the standard deviations of the results from at least three samples.

Fig.: Electroluminescence performance of the display textile and EL unit.

Experiment Results - Efficacy

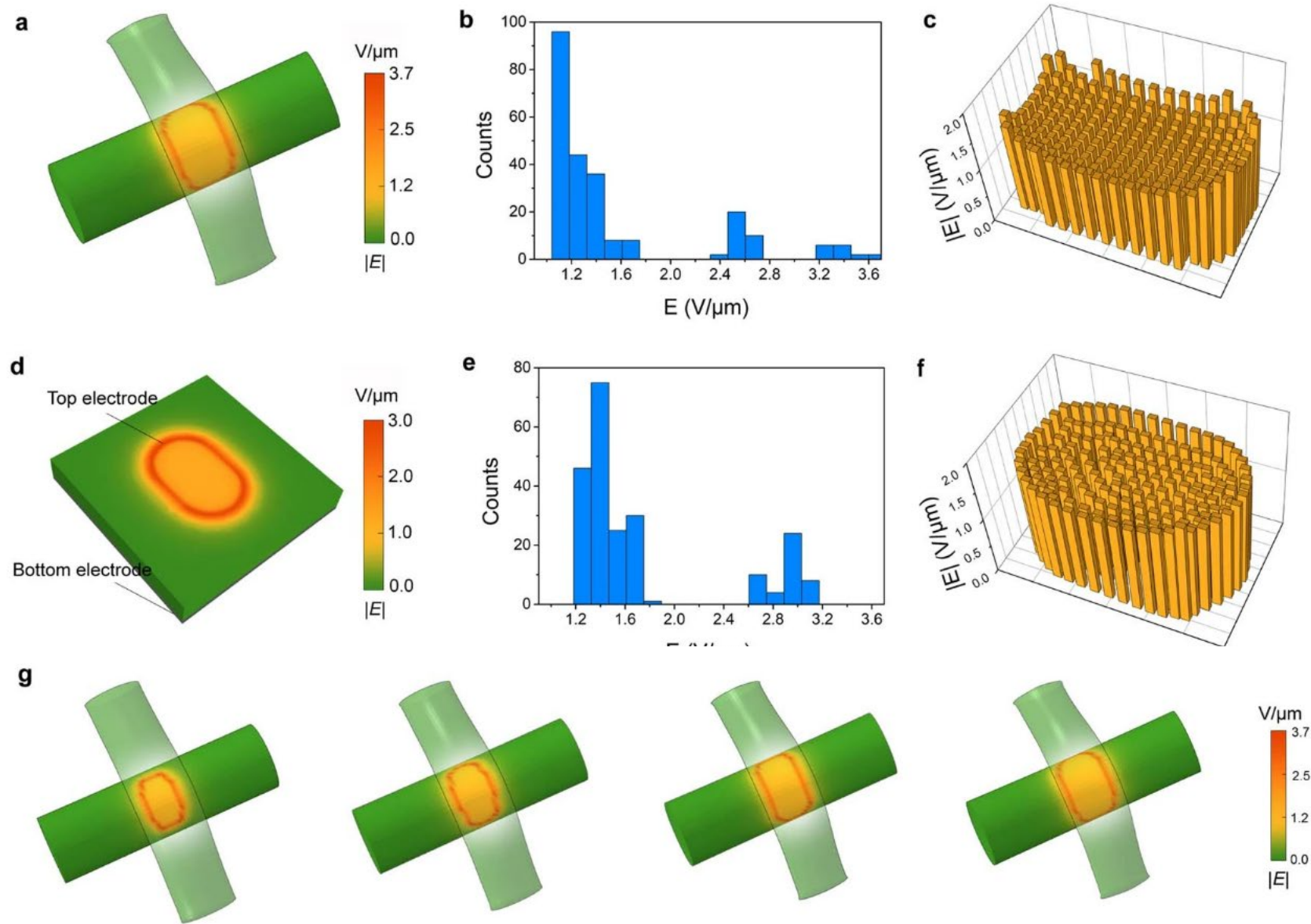
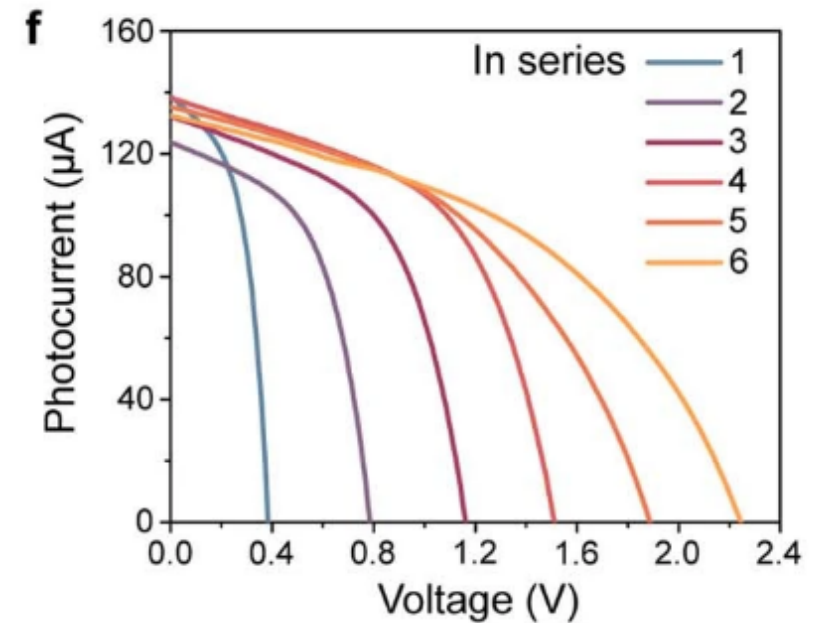
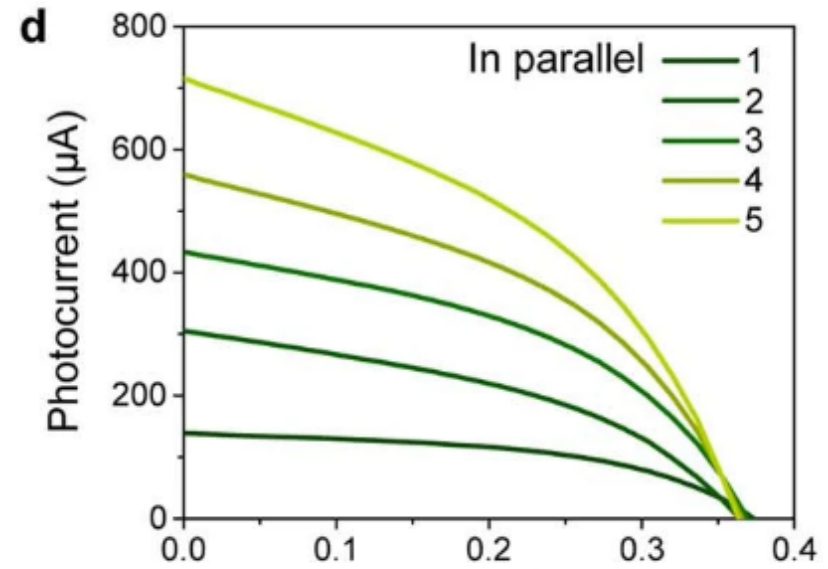
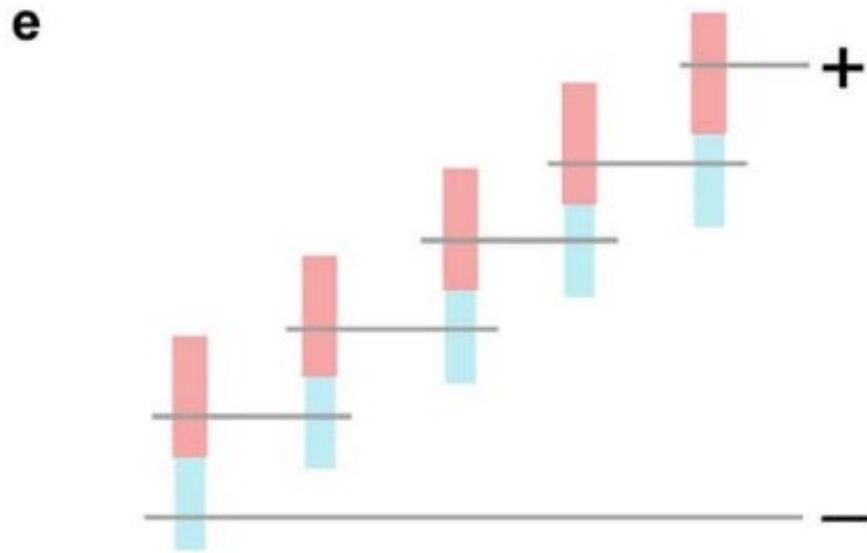
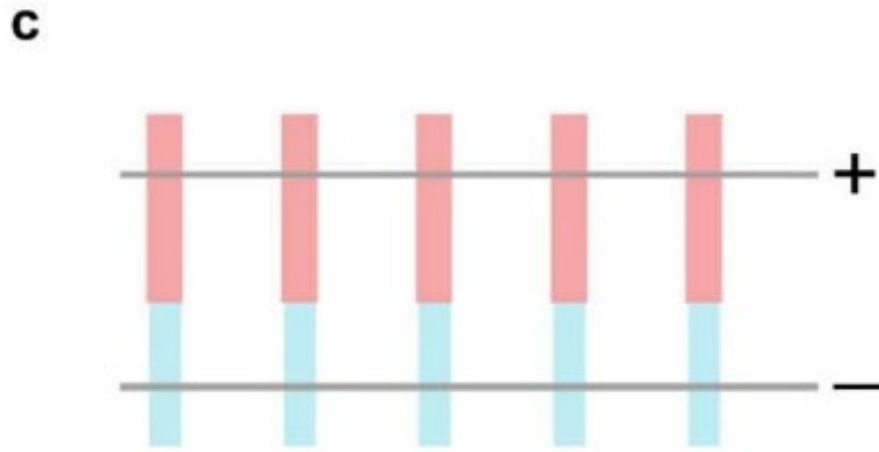


Fig.: Comparison of electric field distribution of curved and planar contact areas.

Art Statement - Efficacy



Connection

- My connection is that with the advancement of wearable fabric technology, the future of clothes is no longer just a piece of clothing. We can ride and send and receive messages according to the navigation displayed on the clothes.
- It can even show people's mental state when necessary. These are all defined as intelligent electronic fabrics, which are considered to be able to effectively promote the rapid integration and development of traditional textile manufacturing and emerging fields such as the Internet of Things, human-computer interaction, big data, and artificial intelligence.
- It is expected to give birth to emerging technologies, which in some ways will bring new changes to people's lifestyles.

