Graphene-based Screen-printed Multifunctional Wearable E-textiles

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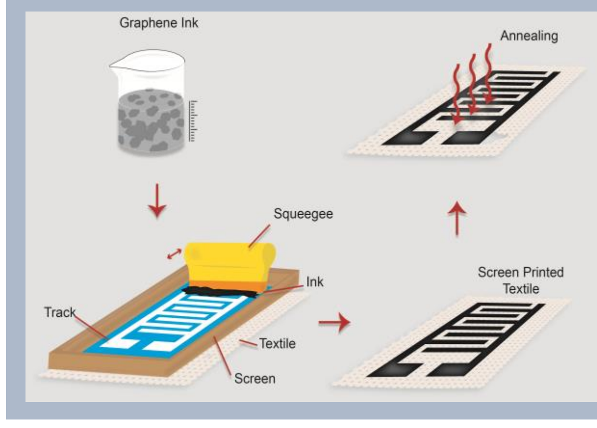
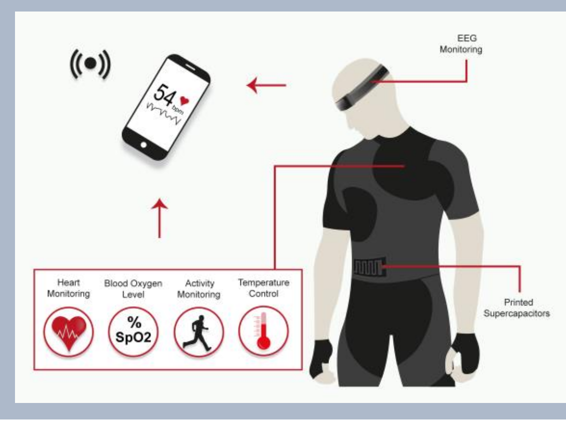
INTRODUCTION

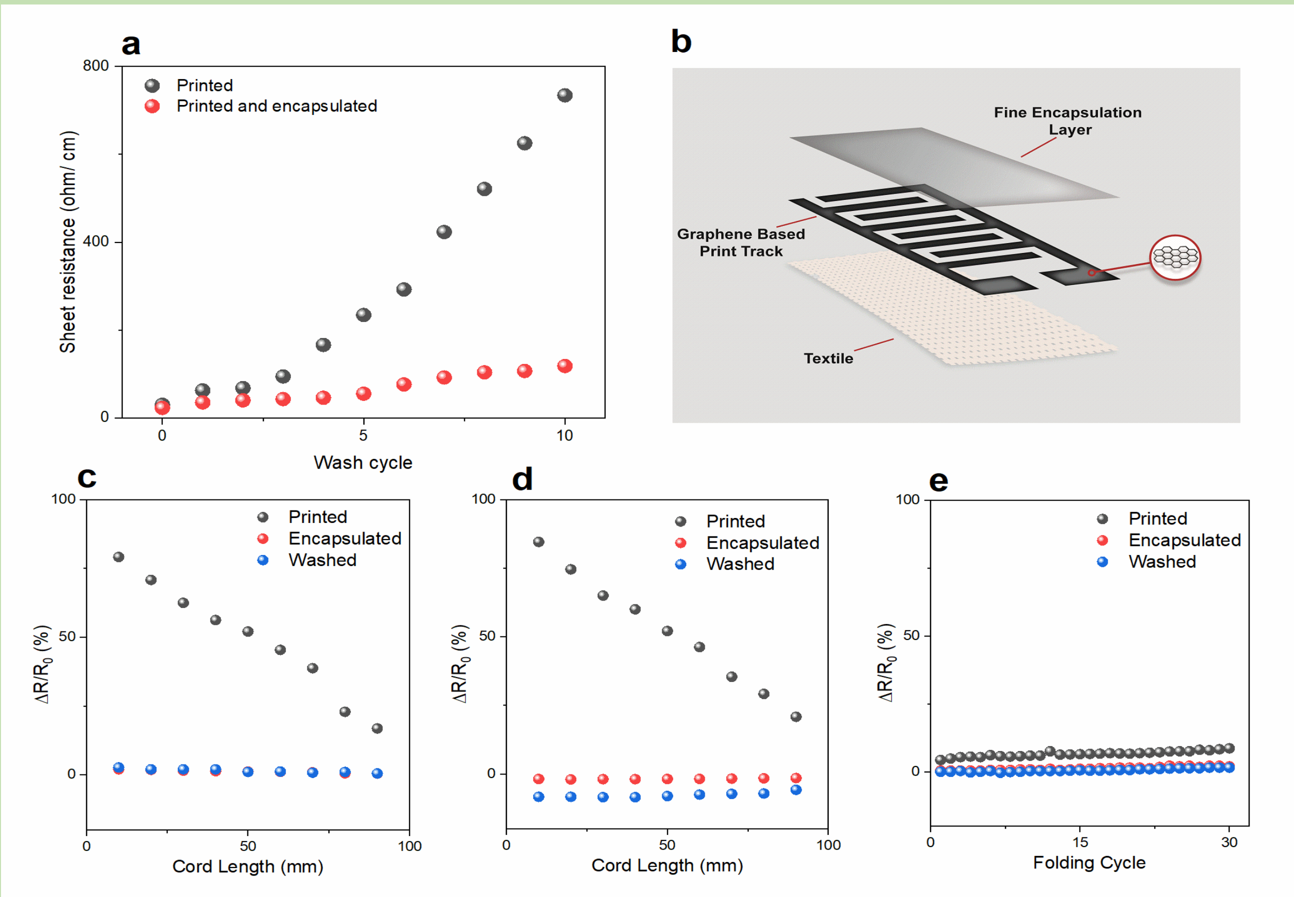
Wearable e-textiles have gained huge tractions due to their potential for non-invasive health monitoring. Here we report a fully-printed, highly-conductive, flexible and machine-washable e-textiles platform that stores energy and monitor physiological conditions including bio-signals. The produced e-textiles are extremely-flexible, conformal, and can detect activities of various body parts. The in-plane printed supercapacitor is able to store energy, as well as the e-textiles pattern is able to record brain activity (an electroencephalogram, EEG).

METHODS

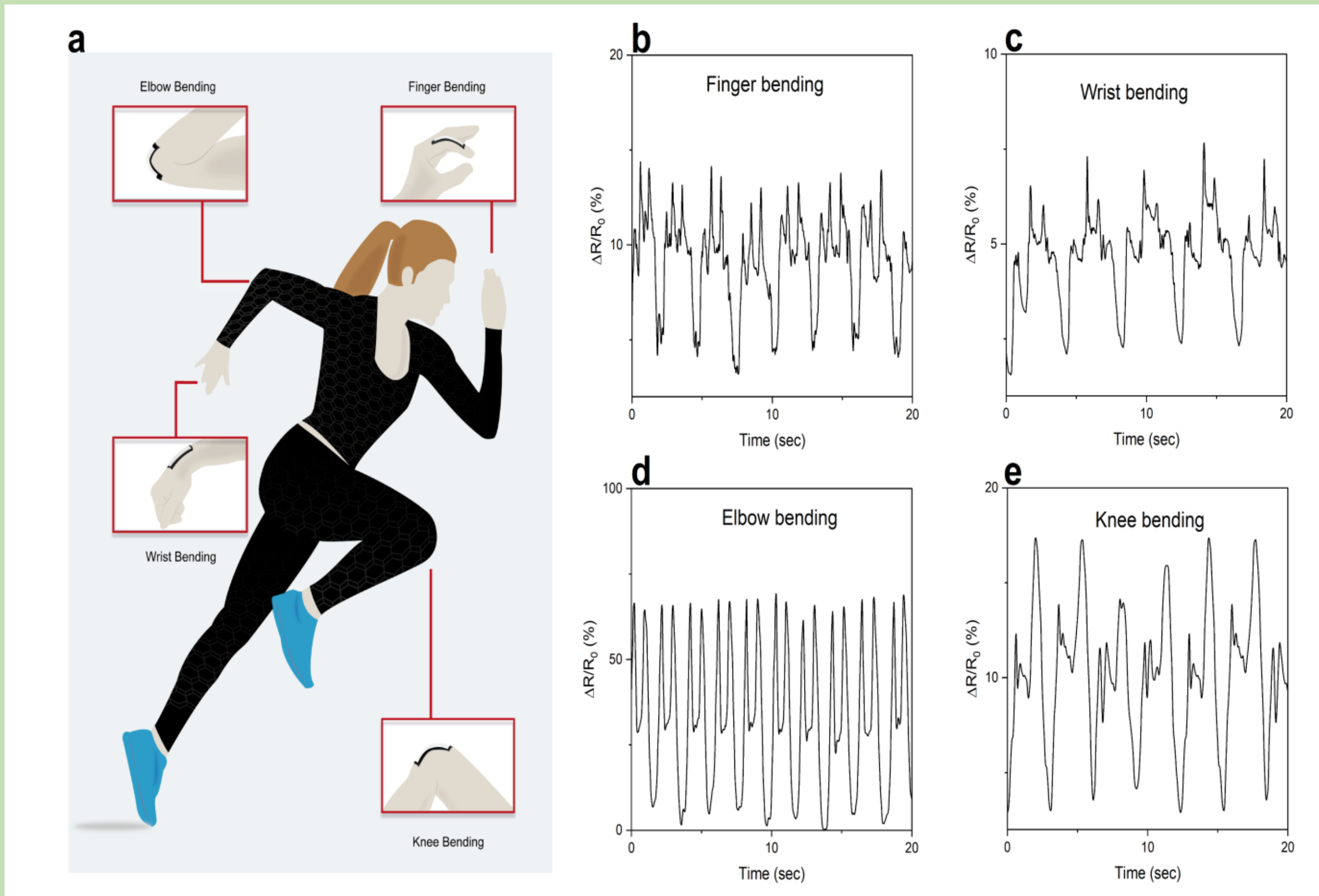




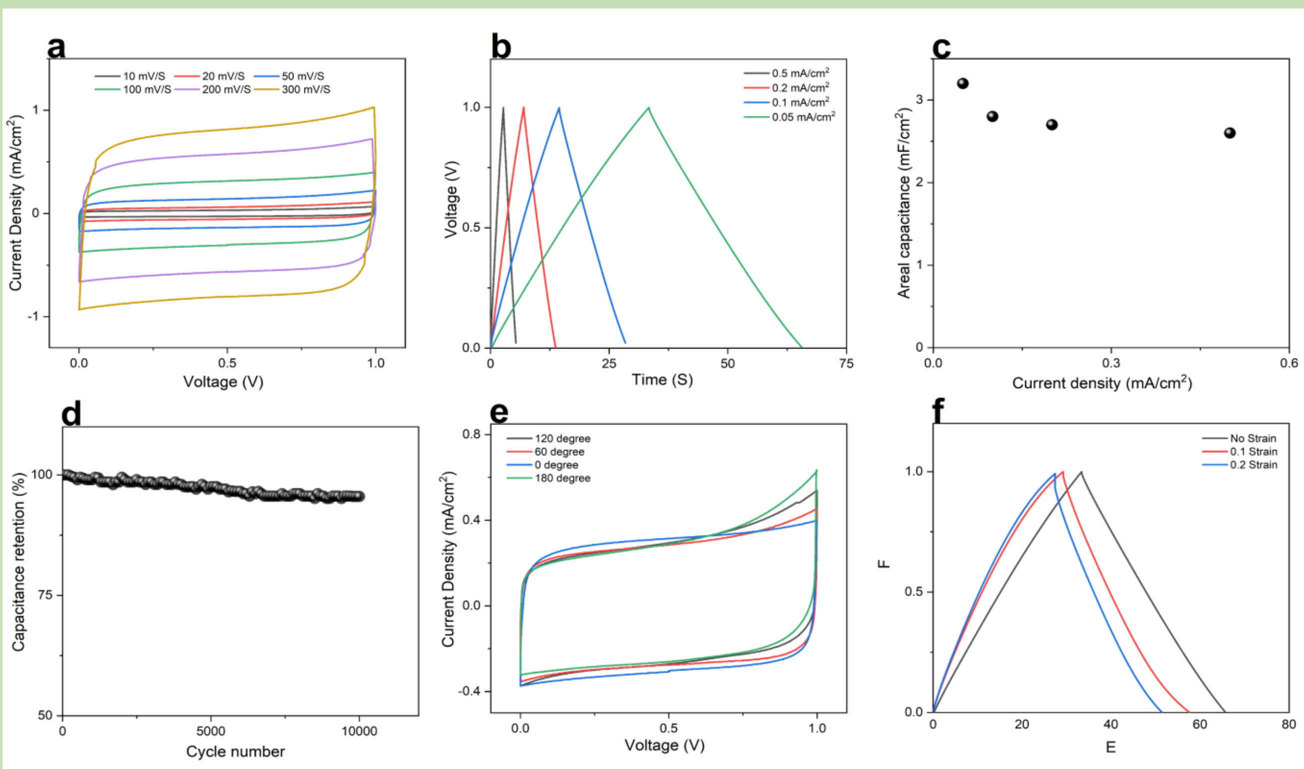
RESULTS



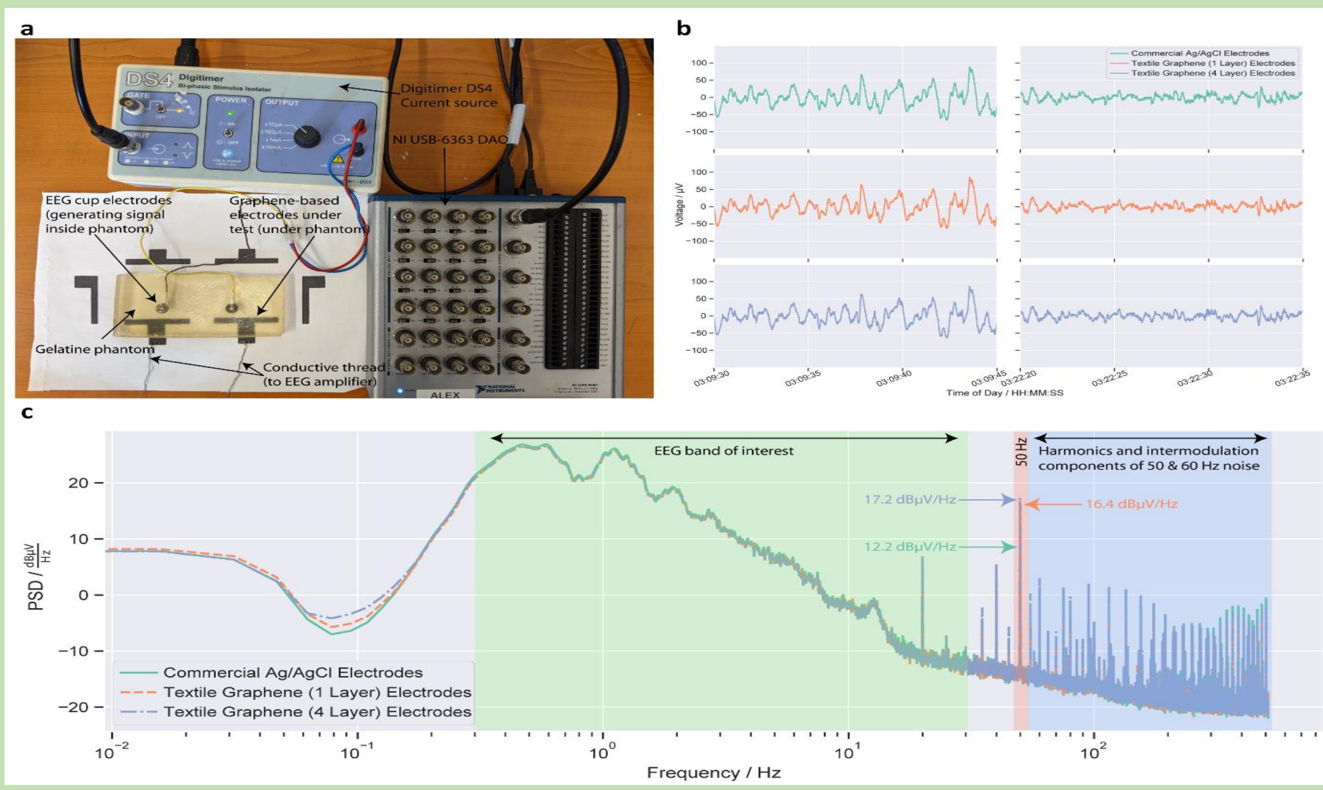
Wash stability and flexibility of printed and encapsulated graphene e-textiles. *a) The change in electrical resistance with the number of washing cycles of graphene-based ink printed (without encapsulation) and graphene-based ink printed (with encapsulation) cotton fabric b) Graphical illustration of graphene-based ink pattern and encapsulation layer on textile substrate c) The variation in resistance of the bending sensor in forward direction d) The variation in resistance of the compression sensor in forward direction e) The variation in resistance under 30 inward (printed pattern inside) folding–releasing cycles.*



Printed graphene e-textiles as Piezoresistive activity monitoring sensors. *a) Schematic diagram showing the application of graphene-based ink printed textiles as activity monitoring sensors at different body parts. The motion detection represented by the change of resistance as a function of time during b) finger joint bending c) wrist joint bending d) elbow joint bending and e) knee joint bending by the graphene-based ink printed textiles.*



Characterization of graphene-based ink printed textile supercapacitor: *a. CV curves at multiple scan rates, b. Charge/discharge curves at various current densities, c. The change of the areal capacitance with the current density, d. The cyclic stability of the printed supercapacitor measured at 0.1 mA cm^{-1}, e. CV of the printed supercapacitor at different bending angles, f. Charge/discharge profile for the supercapacitor with no strain and under strain.*



Printed graphene e-textiles for EEG applications. *a) Experimental setup, b) Data collected using the textile graphene-based electrodes against commercial Ag/AgCl electrodes, c) Power spectral density of recorded signal from graphene textiles electrodes against commercial Ag/AgCl electrodes, highlighting the typical frequency band of interest in EEG studies shaded in green, higher frequency harmonics and intermodulation components from 50 and 60 Hz noise shaded in dark blue.*

CONCLUSION

A potentially multifunctional garment of graphene-based e-textiles. Utilizing the highly scalable screen-printing technology, the obtained e-textiles are extremely-flexible, conformal, and can detect activities of various body parts. The printed in-plane supercapacitor provides an aeral capacitance of ~3.2 mFcm^{-2} (stability ~10,000 cycles). The e-textiles was also used to record brain activity (an electroencephalogram, EEG) and find comparable to conventional rigid electrodes.

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