Electronic Supplementary Material (ESI) for Lab on a Chip.

Electronic Supplementary Information

An Autonomous Wearable System for Diurnal Sweat Biomarker Data Acquisition

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Supplementary Methods

Power consumption calculation

The electronic module (developed based on low/ultra-low power integrated circuit chips) is powered with a single miniaturized rechargeable lithium-ion polymer battery with a nominal voltage of 3.7 V. The battery is embedded within a 3D-printed case, which also contains the LCD display and a FPCB module (Fig. S8). Based on our characterization results (without further power optimization), the core operations (*e.g.*, iontophoresis, sensing, and bilateral wireless communication) altogether demand supply current on the order of ~ 100 mA. For the demonstrated study, which includes periodic sweat sampling (5 minutes of active iontophoresis) and analysis (~ 40 minutes of sensing operation) at 6 points during the day (*i.e.*, monitoring the glucose levels before/after main meals), a battery with a capacity rating on the order of 100 mAh = (150 mA × 0.08 h + 7 mA × 0.67 h) × 6 times/day would meet the diurnal monitoring requirement. It is worth noting that if higher power levels are required, commercially available miniature lithium-ion polymer batteries with larger capacity can be used, or alternatively the used battery can be recharged (assuming that the standard discharge requirements are met).

The custom-developed mobile application design and cloud server storage

The custom-developed Android application provides an interactive graphical user interface to wirelessly activate/deactivate the desired compartment, and independently, control the corresponding iontophoresis and sensing modalities. Additionally, this mobile application timestamps, stores, and displays the delivered iontophoresis current and the sensor readouts in real-time. This application also provides the option to synchronize and store the collected data on a Google cloud server for further analysis.

Supplementary Figures

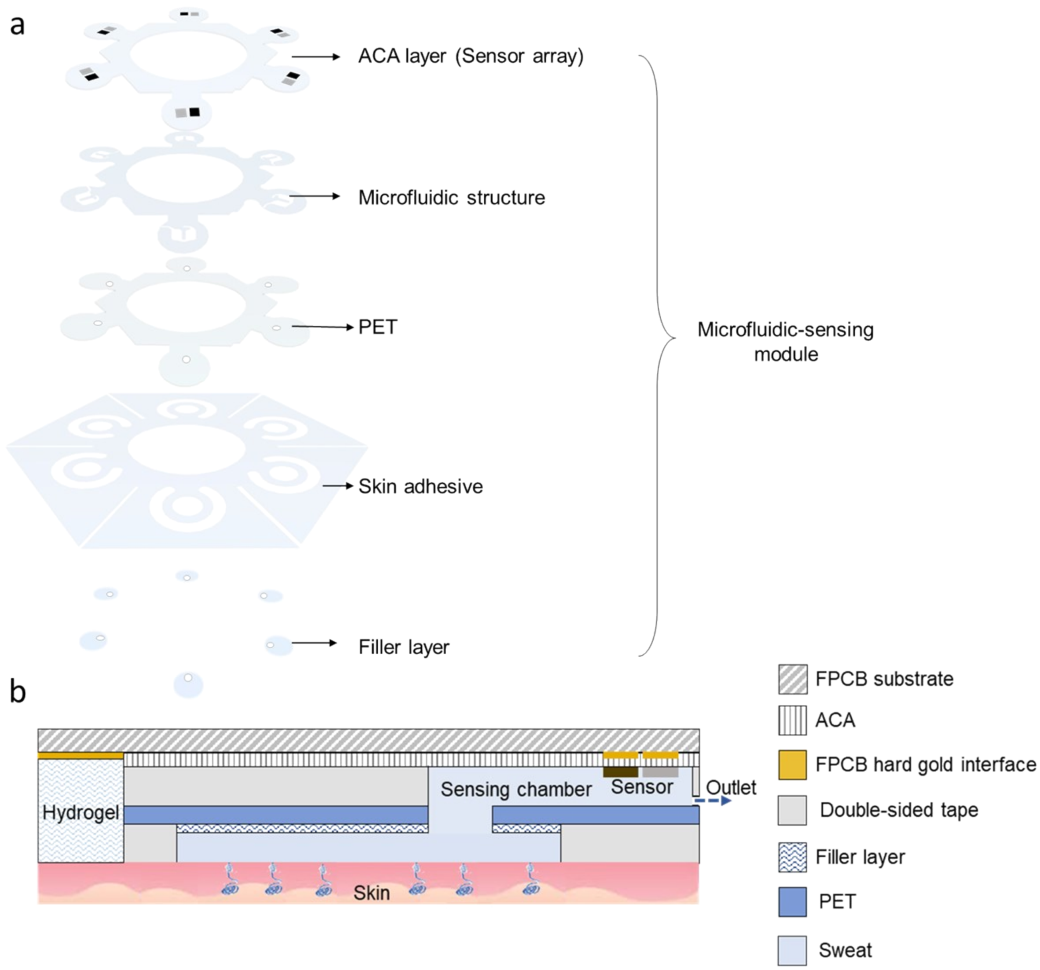

Figure S1: a) Exploded view of the microfluidic-sensing module; b) Cross-section view of the microfluidic-sensing module-skin interface.

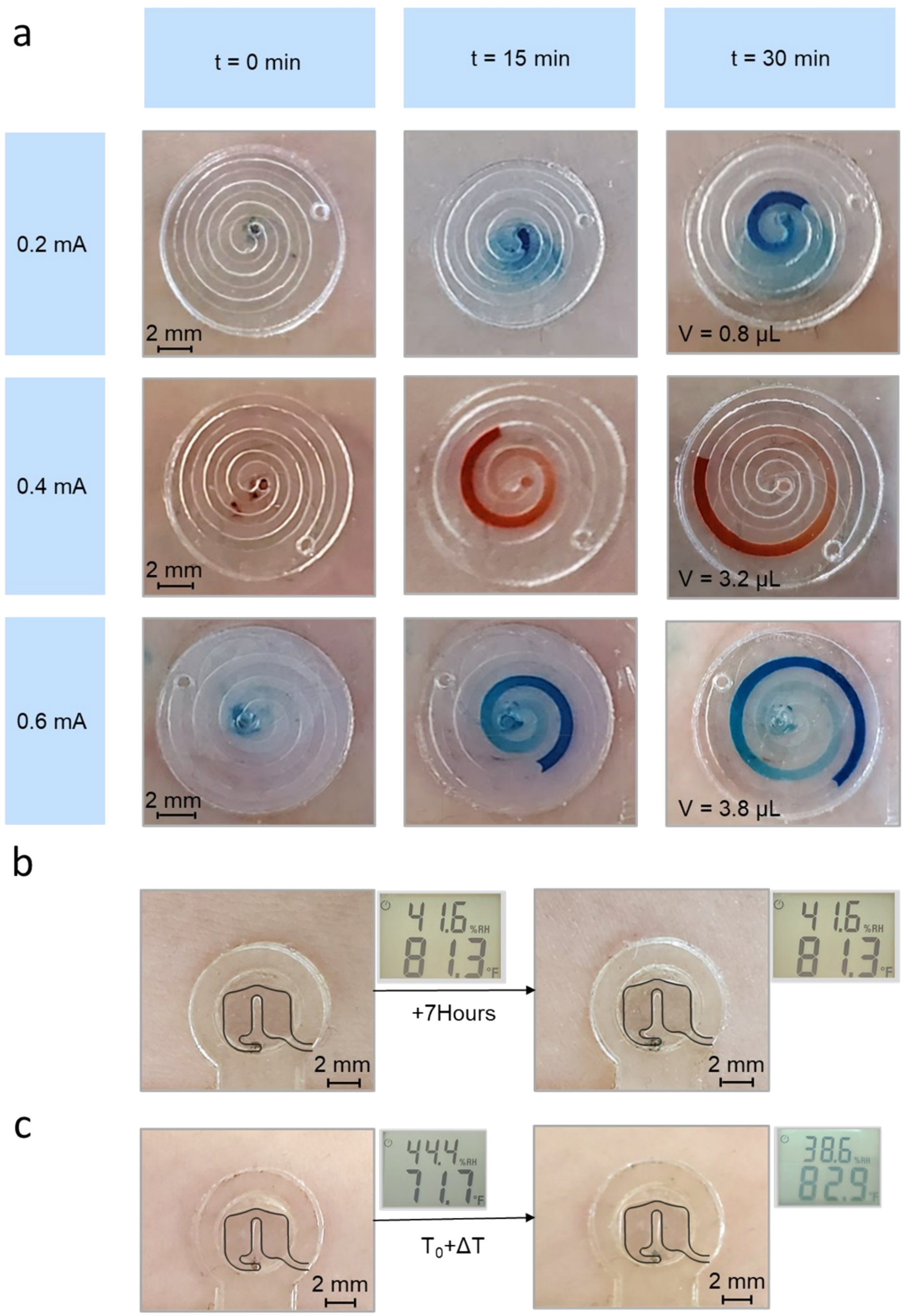

Figure S2: a) Optical sweat secretion characterization (with the aid of color dyes embedded in the channel), following three different iontophoresis current levels; b) Optical image of a compartment illustrating negligible accumulation of sweat sample due to natural perspiration after 7 hours of non-labor daily activities; c) Optical image of a compartment illustrating negligible accumulation of sweat sample (over 2 hours) upon a moderate increase in the ambient temperature from ~ 22 °C to ~ 28 °C (equivalently, ~ 72 °F to ~ 83 °F, as measured and shown by a lab digital thermometer).

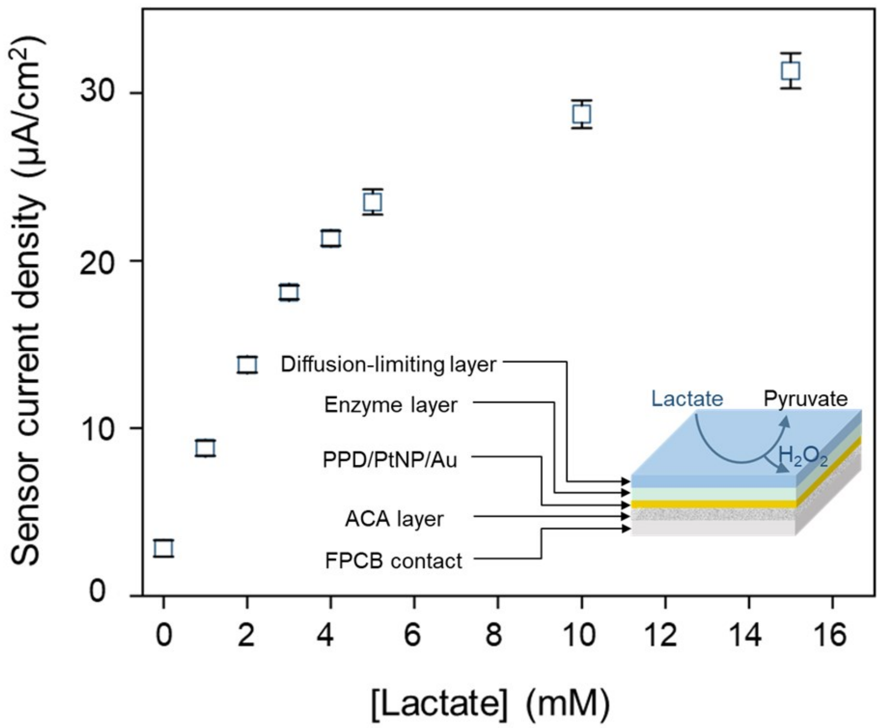

Figure S3: The developed lactate sensor's responses to different lactate solutions (SE, *n* = 3). Inset illustrates the underlying layers of the constructed lactate sensing interface.

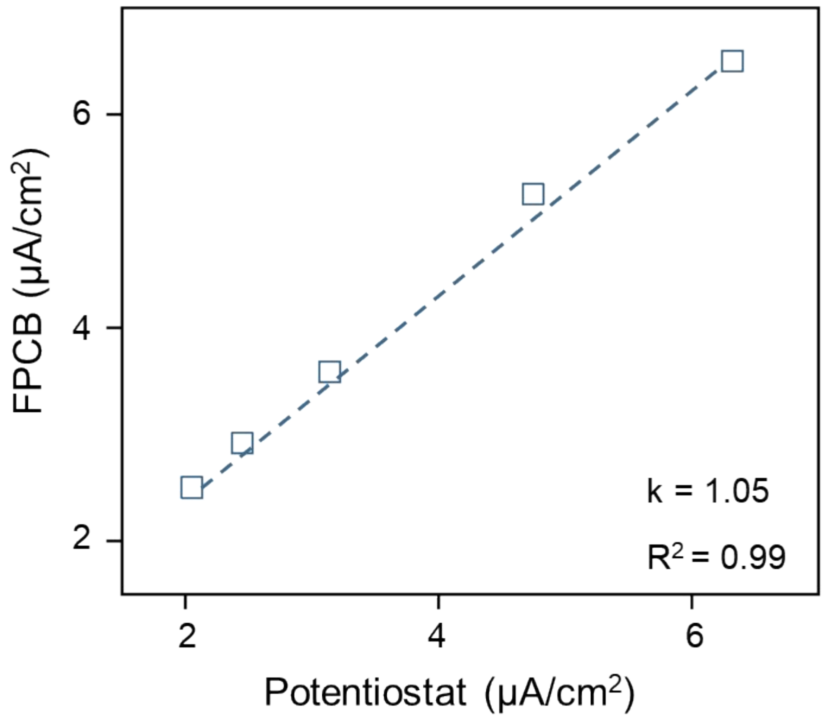

Figure S4: Comparison of glucose sensor readouts (current density) captured by the FPCB *vs*. potentiostat.

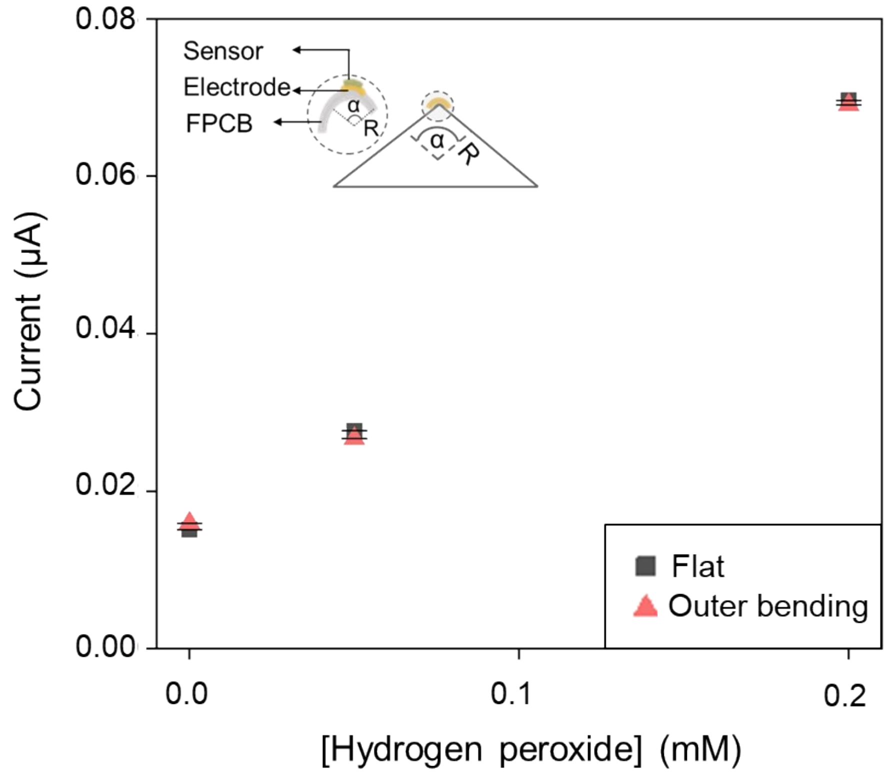

Figure S5: Evaluation of the PtNP/Au electrode (sensor substrate) response to hydrogen peroxide under different bending conditions (1. no bending, and 2. $\alpha = 60°$, $R = 15$ mm).

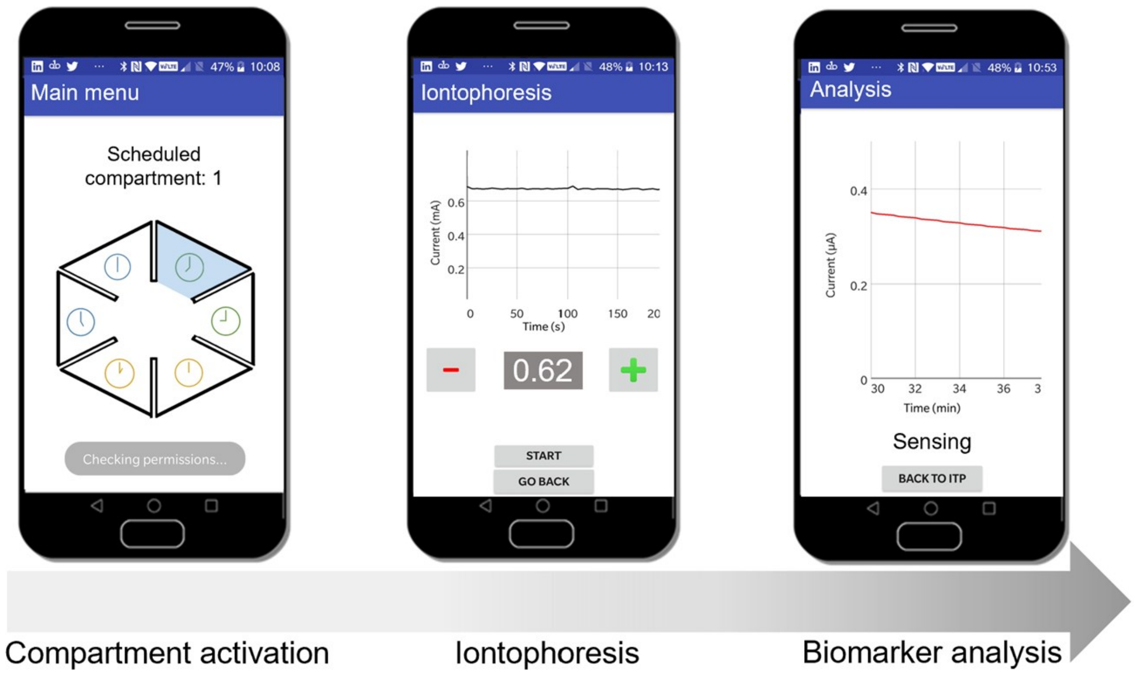

Figure S6: The custom-developed mobile application to control compartmentalized operations (programmable iontophoresis and sensing) and data display/storage.

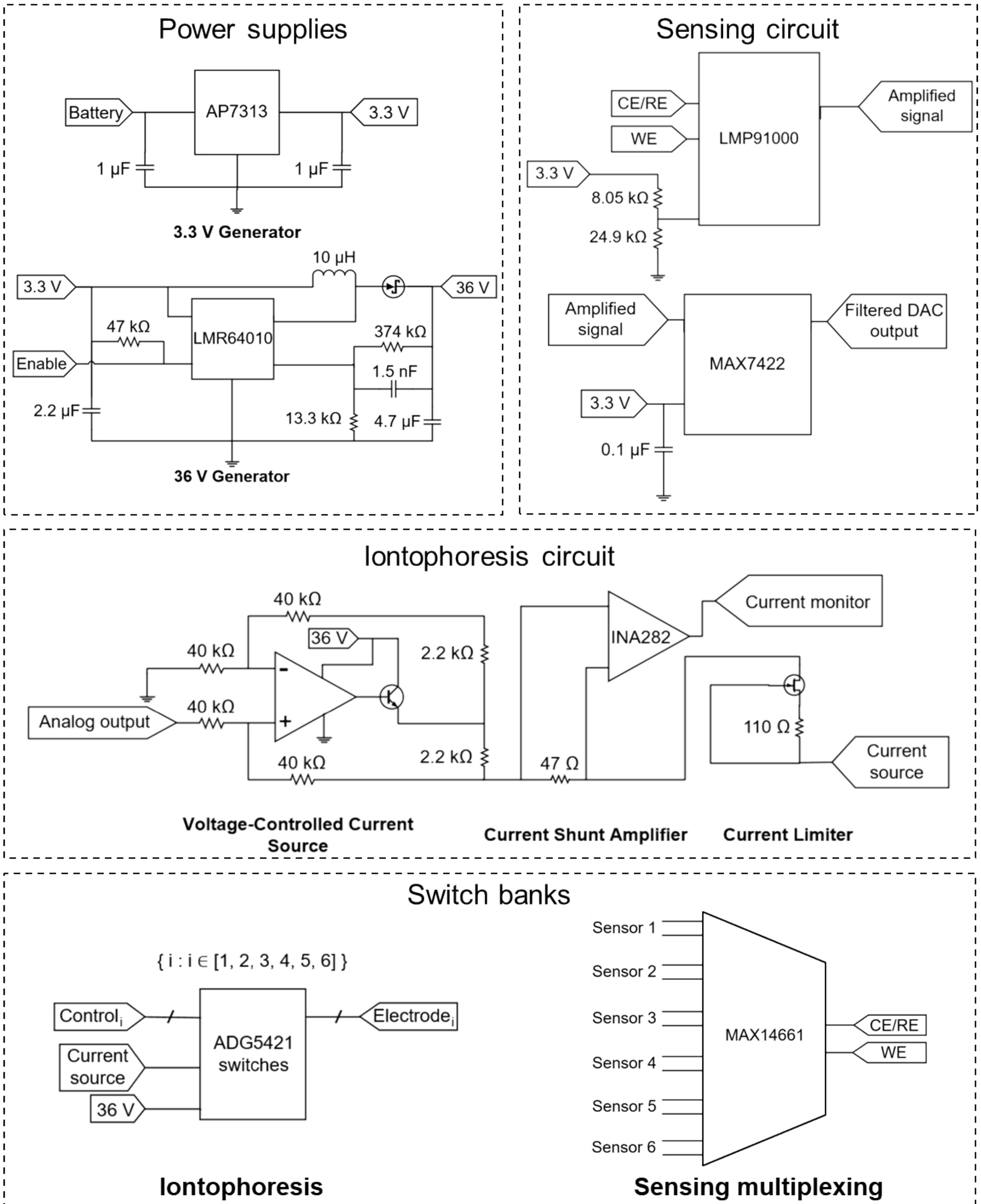

Figure S7: Schematic diagram of the wireless FPCB's circuitries.

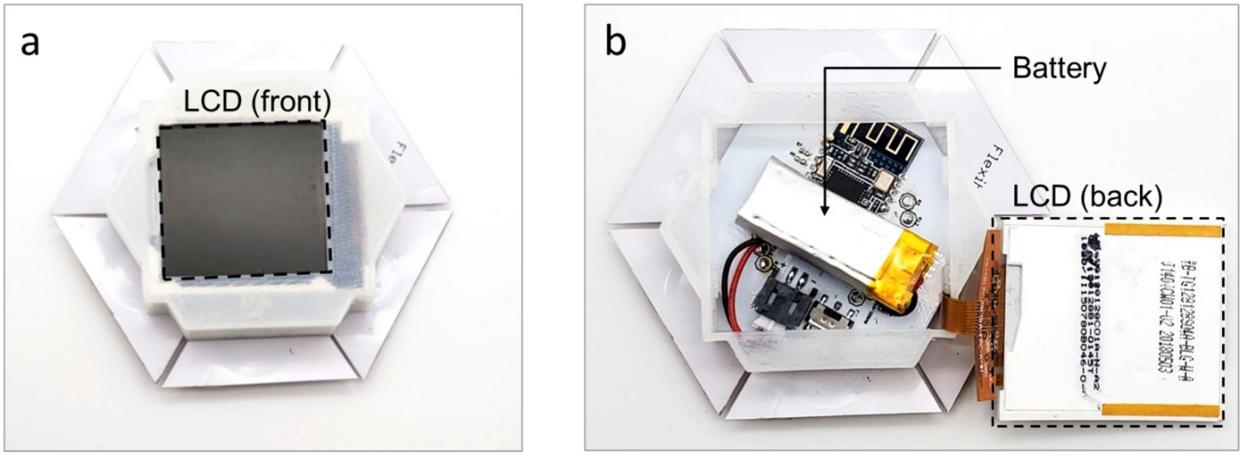

Figure S8: Photographs of the system illustrating the LCD display (a) and a rechargeable lithium-ion polymer battery with 150 mAh capacity (b) enclosed by/embedded within a 3D-printed case.