A fully wearable conductive yarn-based potentiometric ion sensor, self-powered by TENG in shoe sole for analysing sodium in sweat

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Abstract

Sweating during vigorous aerobic workouts leads to sustained loss of water and electrolytes from the human body (hypohydration). This is known to increase physical and cardiovascular strain and thereby degrade the performances of athletes [1]. Since the rate and composition of sweat loss vary among and within individuals [2], a wearable continuous sweat monitoring system will be an invaluable resource for athletes to analyse their electrolyte loss during workouts and to get personalized fluid and electrolyte replacement suggestions [3]. Moreover, the usage of batteries to power these sensors is known to make them rigid, bulky and less wearable and importantly, reduce the devices' life span [4]. The incorporation of wearable energy harvesters can overcome this challenge. Herein we fabricated a wearable potentiometric sweat sensor based on carbon ink-coated cotton yarns as a conductive electrode, functionalised with an ion-selective membrane, and powered by a soft and flexible PDMS-based triboelectric nanogenerator. Due to their flexible and highly mouldable nature, the TENG was incorporated into the heel portion of the shoe sole to generate energy from the motion of the foot during workout and the proposed potentiometric sensor was attached towards the opening of the socks, facing the skin. Using a low-power BLE module the collected data was transmitted to an external user interface for easy data display. This system has potential applications beyond monitoring sodium ions and can be seamlessly integrated into fabric, making it a promising technology for future wearable biosensing devices.

References

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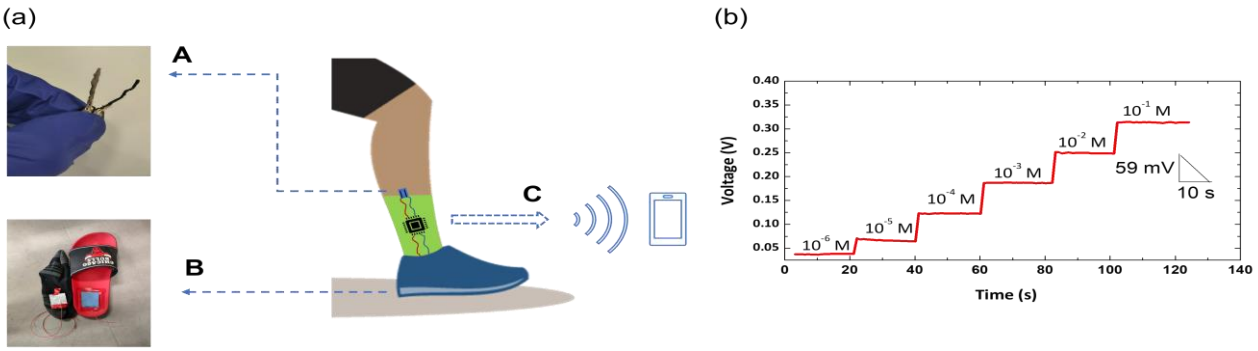
Figures



(a)Illustration of self-powered Na^+ wearable sensor with (**A**) conductive ink-coated cotton yarn-based sensing unit, (**B**) shoe sole based TENG and (**C**) BLE module. (b) Response obtained when different concentrations of Na^+ were added to the sensor.