STEPs Ahead: Self-Powered Triboelectric Nanogenerator for Dynamic Multidirectional Pressure Sensing

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Advancements in human machine interface and human motion monitoring require effective real-time pressure sensing to provide enhance interactive capabilities and enable smart feedback systems. However, developing a sensor with a simple fabrication process that combines mass reproducibility and high sensitivity at clinically relevant pressure range has remained a significant obstacle. Herein, a self-powered triboelectric nanogenerator (TENG) based pressure sensor (STEPs) with real-time remote sensing ability is proposed to meet these critical demands, offering high sensitivity in clinically relevant range of 0 - 70mmHg, catering to the needs of various applications. STEPs introduces an innovative composite material, homogeneously blending Carbon Black (CB) and Polyvinylpyrrolidone (PVP) in Polydimethylsiloxane (PDMS) matrix at optimal content ratio via ultrasonication and degassing for unprecedented performance characteristics. Together with the unique three-dimensional structure, STEPs achieved high surface charge density, leading to a high sensitivity of 2.61 ± 0.02 mV/mmHg with excellent linearity of R-square ≈ 0.9962, while following a much simpler fabrication process as compared with previous works. A wireless measurement and data transfer system, established between an array of STEPs for multidirectional pressure sensing and a remote readout device with 2.5 Hz refresh rate, further enables real-time remote display of pressure readings. It is envisioned that this highly sensitive sensor is broadly applicable to many fields, with significant potential for commercialisation in both human-machine interface and biomedical applications.

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