Supplementary Information (SI) for Nanoscale.
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Supplementary Information

Instantaneous self-powered wireless sensing system based on TENG and human body

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1. Performance of breakdown switch

The function of the breakdown switch is to minimize the output impedance of the TENG, as impedance matching is crucial for maximizing the energy output of the TENG and subsequently enhancing the energy harvested by the LC circuit. It is well know that a device can deliver its maximum energy output when the load resistance is equal to its internal resistance. Tests conducted on a TENG without a breakdown switch under various load resistances revealed the corresponding peak voltage outputs, as illustrated in **Fig. S1a**. Additionally, the instantaneous power output as a function of load resistance was demonstrated, where power is calculated using P=U2/R. At an optimal load resistance of approximately 50 MΩ, the maximum peak power reached 12 mW, corresponding to a peak power density of 4.8 W/m². This indicates that the internal resistance of the TENG without a breakdown switch is approximately 50 MΩ.

Such a high internal resistance complicates direct impedance matching with external circuits, particularly the resonant circuit used in this sensor system, which typically has an impedance in the range of a few kilo-ohms. **Fig. S1b** presents the voltage and peak power output of the TENG integrated with a breakdown switch under various load resistances. The matching resistance for the TENG output was successfully reduced from 50 MΩ to approximately 15 kΩ, with the output voltage increasing to about 1400 V and the instantaneous peak power reaching 40 W, corresponding to a peak power density of 16000 W/m², significantly surpassing the TENG without a microswitch. Furthermore, the substantial reduction in matched load resistance allows for the connection of the TENG to a resonant circuit, which receives a larger power input, thereby enabling the HB-WTENG to operate over relatively longer transmission distances. It should be noted that the energy harvested by TENGs, with and without a breakdown switch, would be similar; the significant voltage and peak power output are attributed to the very short discharge time of the same amount of charge.

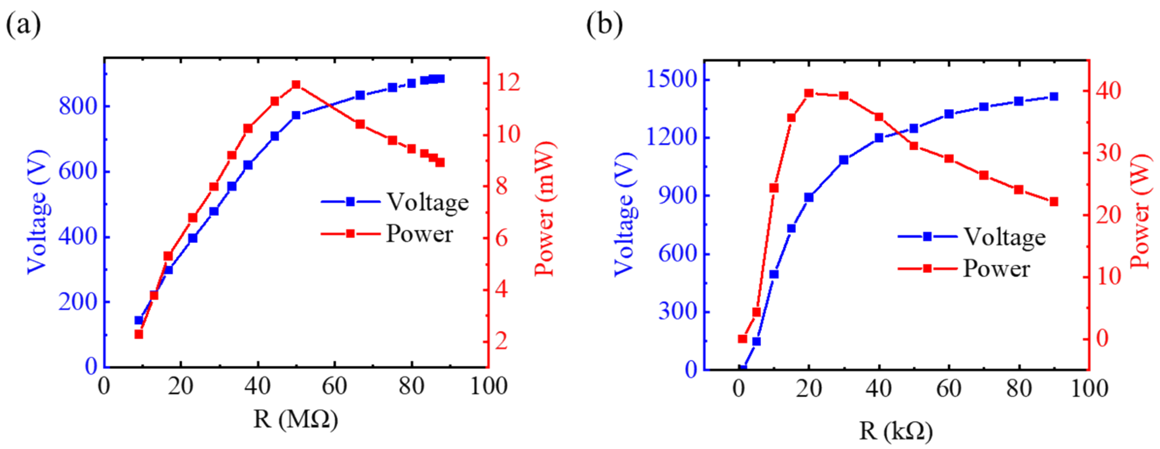

Fig. S1: (a) The peak output voltage and power of TENG under different loads without breakdown switch. (b) The peak output voltage and power of TENG under different loads with breakdown switch.

2. Stability characterization of frequency and amplitude

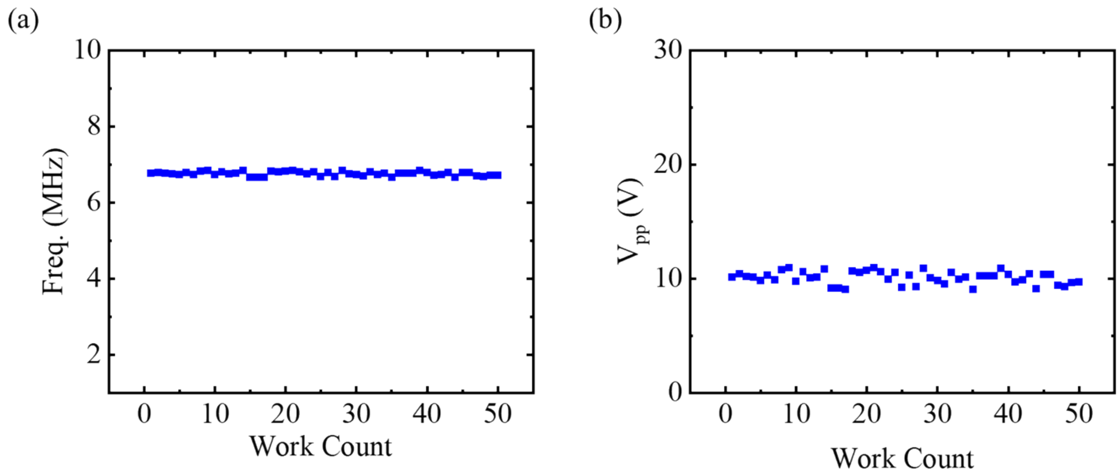

Fig. S2: Stability Characterization of HB-WTENG Using Parameters Specified in Table 1. (a) Frequency stability of HB-WTENG after 50 consecutive operations. (b) HB-WTENG amplitude stability under 50 consecutive operations.

3. Waveforms with different sizes of metal plates at the receiver

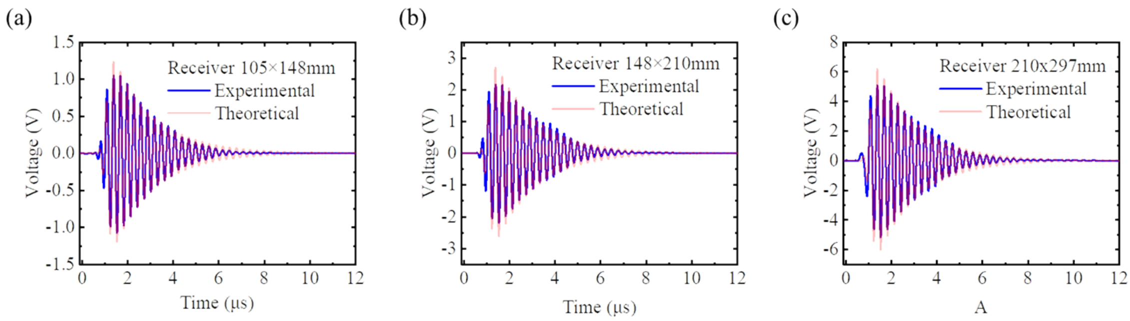

Fig. S3: Waveforms with different metal electrode sizes at the receiving end located at 8m. (a) The size of the metal plate is 105 x 138 mm. (b) The size of the metal plate is 148 x 210mm. (c) The size of the metal plate is 210 x 297 mm.

4. Detailed views of the HB-WTEGN System in wearable experimental setups

(a)

(b)

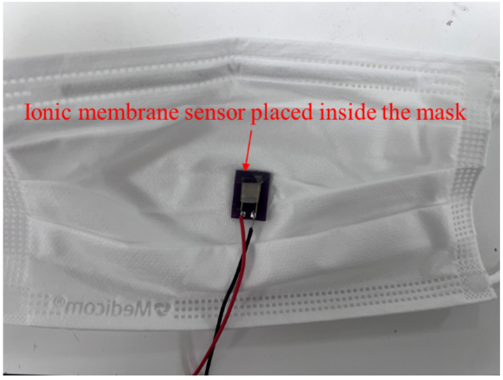

Fig. S4: (a) Enlarged view and detailed configuration of the experimental setups for measuring different gait patterns. (b) A photo of the iontronic pressure sensor within a face mask for measuring respiration.