Supplementary information

Piezoelectric Nanofiber/Polymer Composite Membrane for Noise Harvesting and Active Acoustic Wave Detection

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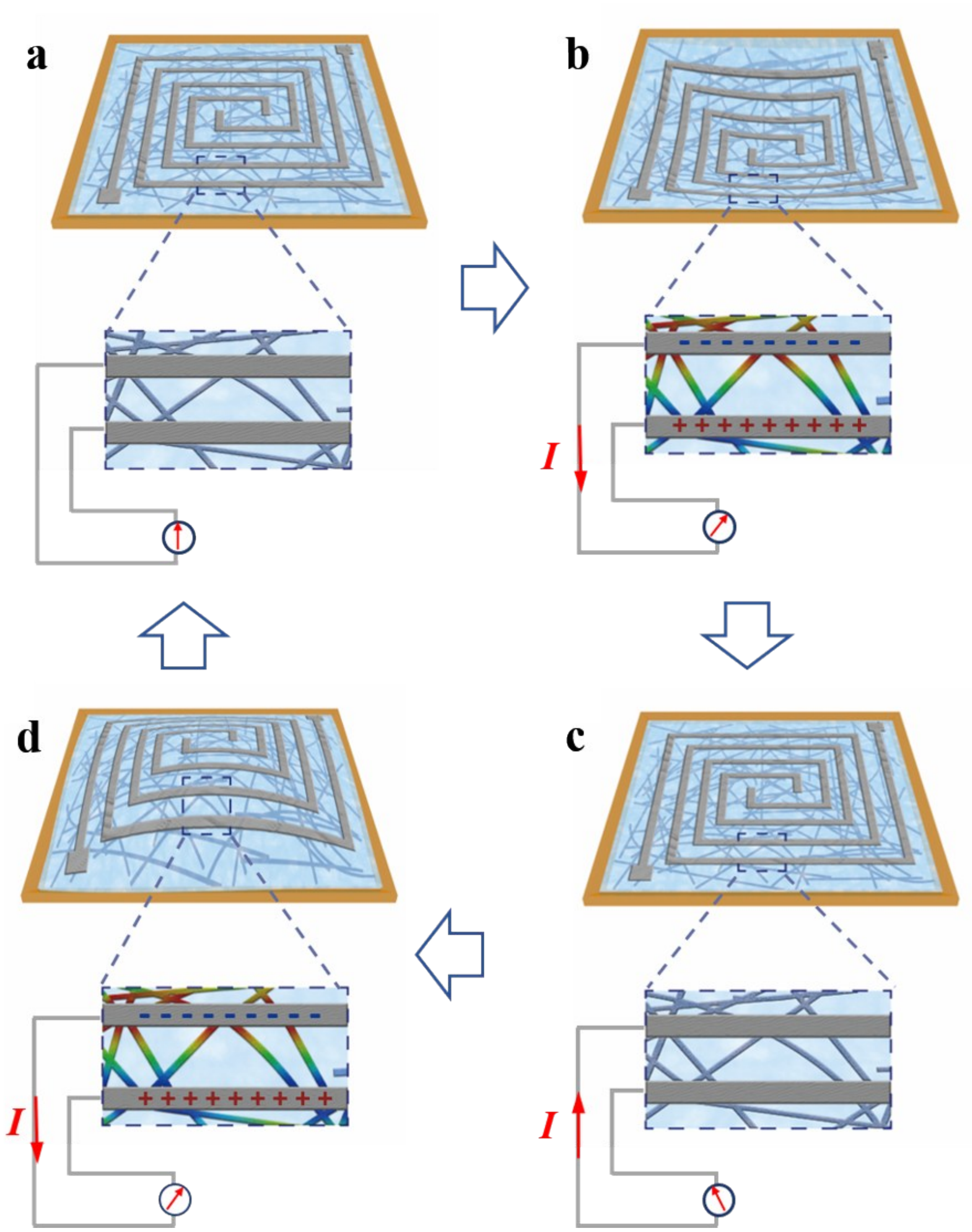

Figure S1. The detailed working mechanism of the membrane PENG: (a) the original state of the PENG; (b) the process of the membrane bent downward, where the membrane and nanofibers are stretched and result in a piezoelectric potential, and the external electrons flow to screen the piezoelectric potential and thus form a current; (c) the situation of the membrane recovered, where the piezoelectric potential disappears and the external electrons flow reversely to the original state and form a reverse current; (d) the process of the membrane bent upward, where the membrane and nanofibers are still stretched and result in a piezoelectric potential similar to (b).

Derivation S1. The derivation process of equation 2.

$$\frac{V^2}{R} = kI$$

$$\frac{V^2}{RI_0} = k\frac{I}{I_0}$$

$$log_{10}\frac{V^2}{RI_0} = log_{10}k\frac{I}{I_0}$$

$$log_{10}V^2 - log_{10}RI_0 = log_{10}k + log_{10}\frac{I}{I_0}$$

$$2log_{10}V - log_{10}RI_0 = 0.1SIL + log_{10}k$$

$$log_{10}V = \frac{1}{20}SIL + \frac{1}{2}(log_{10}k + log_{10}RI_0)$$

V is the peak to peak value of voltage, SIL is the sound intensity, $SIL = 10log_{10}I/I_0$, I is the energy flux density of sound, I_0 is the basic parameter which equals to 10^{-12} Wm^{-2}, R is the load resistance which equals to 100 MΩ, and k is a scale factor which is related to the energy conversion efficiency.

Derivation S2. The derivation process of the energy exchange efficiency μ.

First, we can get the intercept of the fitting is -4.76,

and $\frac{1}{2}(log_{10}k + log_{10}RI_0) =- 4.76487$

$$k = 2.953E - 6.$$

The voltage curve follows a sine function, so

$$P_{power} = \frac{\left(\frac{(V/2)}{\sqrt{2}}\right)^2}{RS} = \mu I$$

$$\frac{V^2}{R} = 8 \times S\mu I$$

so

$$k = 8 \times S\mu.$$

S is the active area of the vibrating membrane which equals to 0.43E-4 m^2. So the energy exchange efficiency μ equals to 0.86 %.

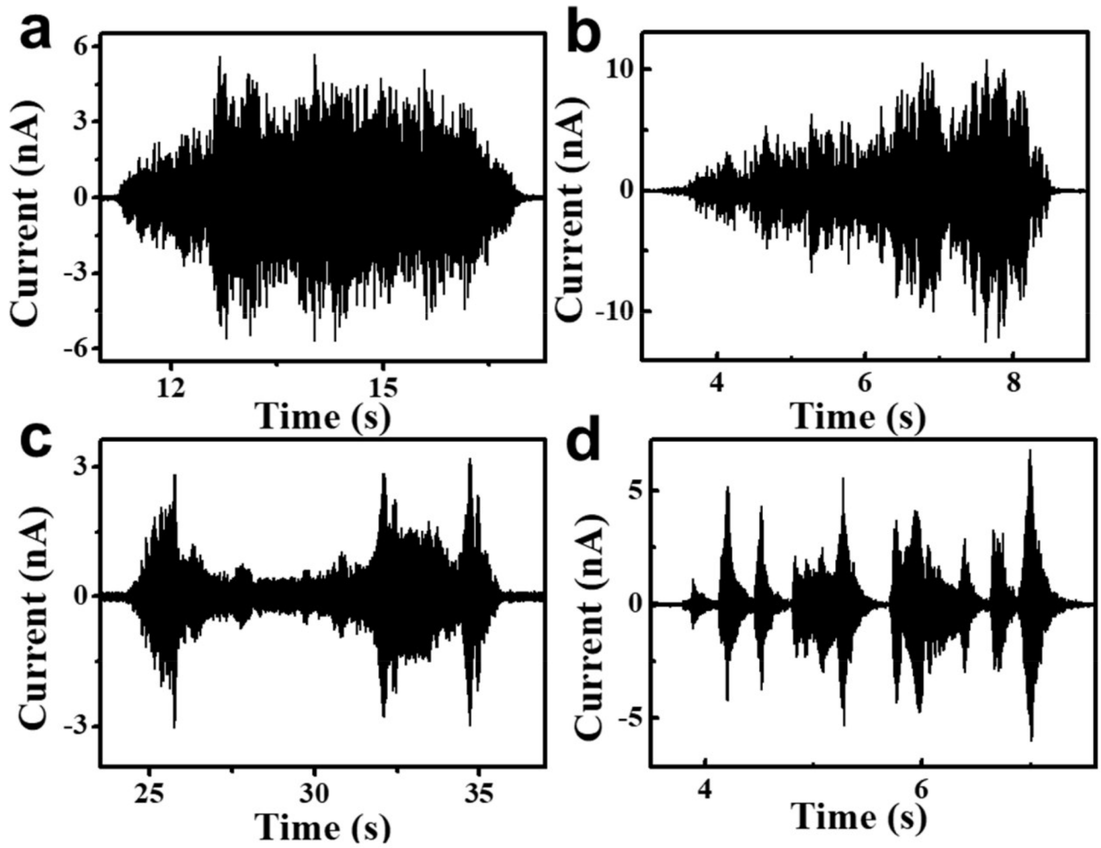

Figure S2. Current responses of PENG to (a) the noise of a simulative workshop; (b) the sound of a helicopter taking off; (c) the sound of an alarm; (d) a man's voice saying "Merry Christmas!"

Video S1. A restored song converted from the output current signals of the PENG.