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Enhancing PDMS-based triboelectric nanogenerator output by optimizing microstructure and dielectric constant

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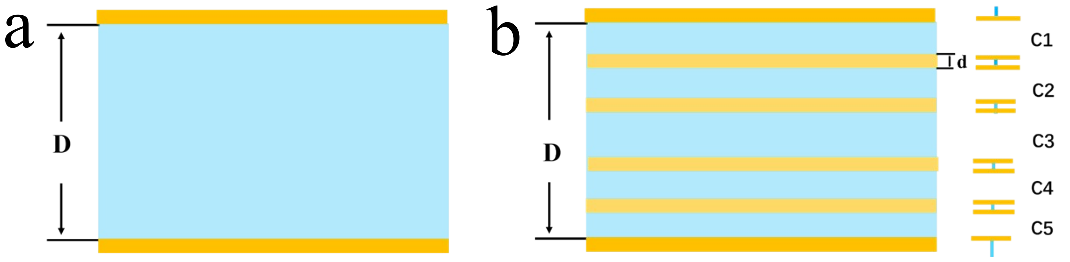

Fig. S1 Schematic of the capacitor structure with the introduction of metallic materials in PDMS. (a) a classic capacitor plate model, (b) the metal plate embedding model.

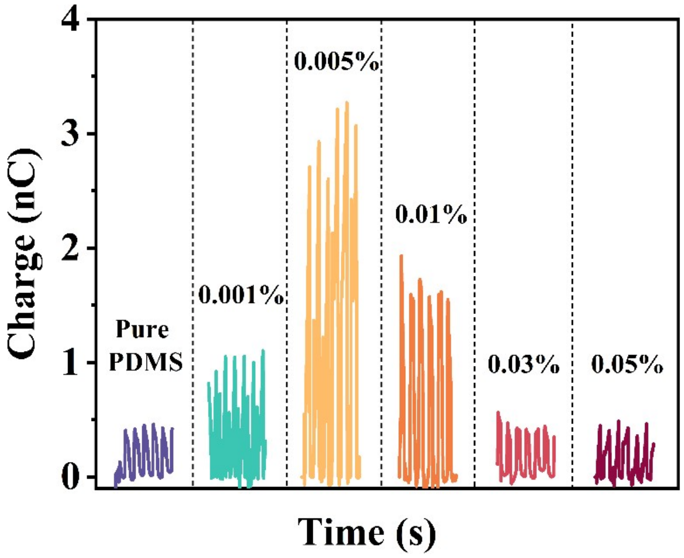

Fig. S2 Q_{oc} of PDMS/Ag NWs at 1 Hz and 53.57 kPa pressure.

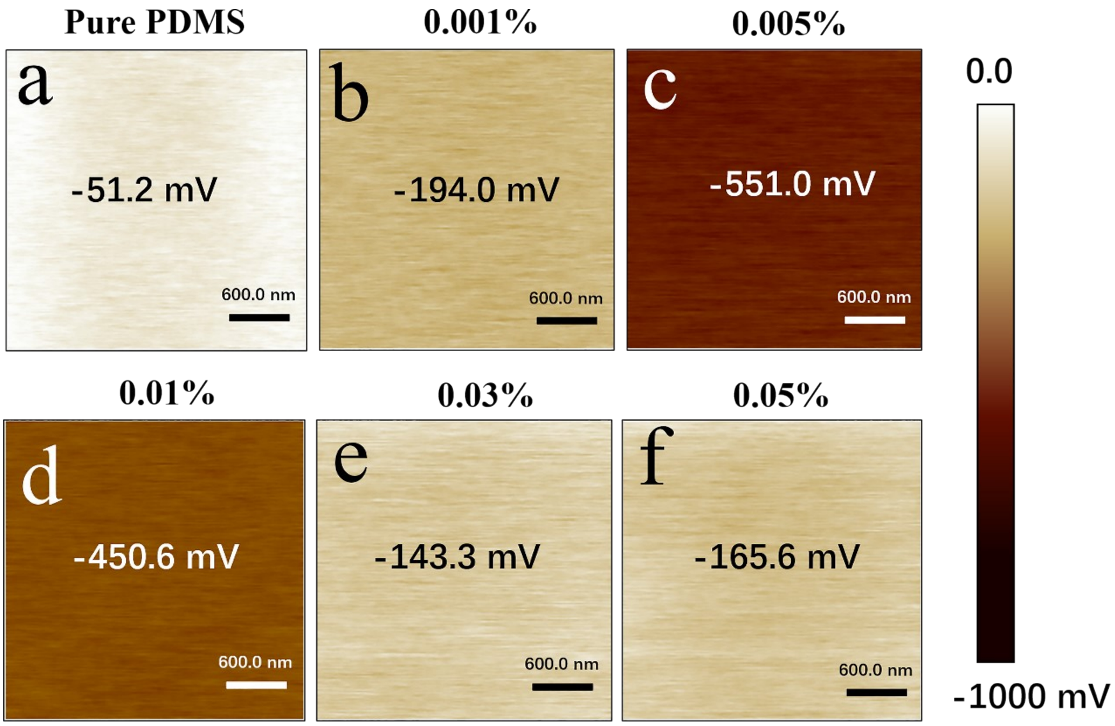

Fig. S3 Surface potential of different samples measured by KPFM. (a) pure PDMS film, (b) 0.001% Ag NWs, (c) 0.005% Ag NWs, (d) 0.01% Ag NWs, (e) 0.03% Ag NWs, (f) 0.05% Ag NWs.

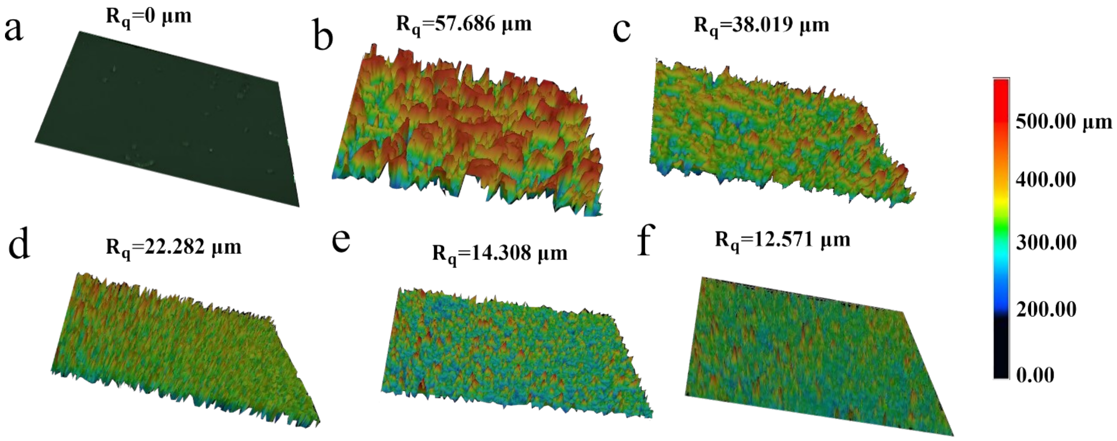

Fig. S4 3D laser scanning microscope photographs of pure PDMS film (a), 180 PDMS film (b), 320 PDMS film (c), 600 PDMS film (d), 800 PDMS film (e) and 1000 PDMS film (f).

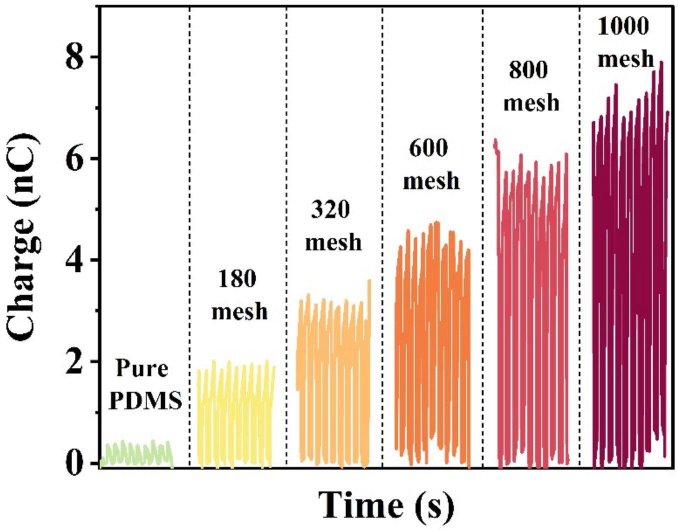

Fig. S5 Q_{oc} of microstructure PDMS film at 1 Hz and 53.57 kPa pressure.

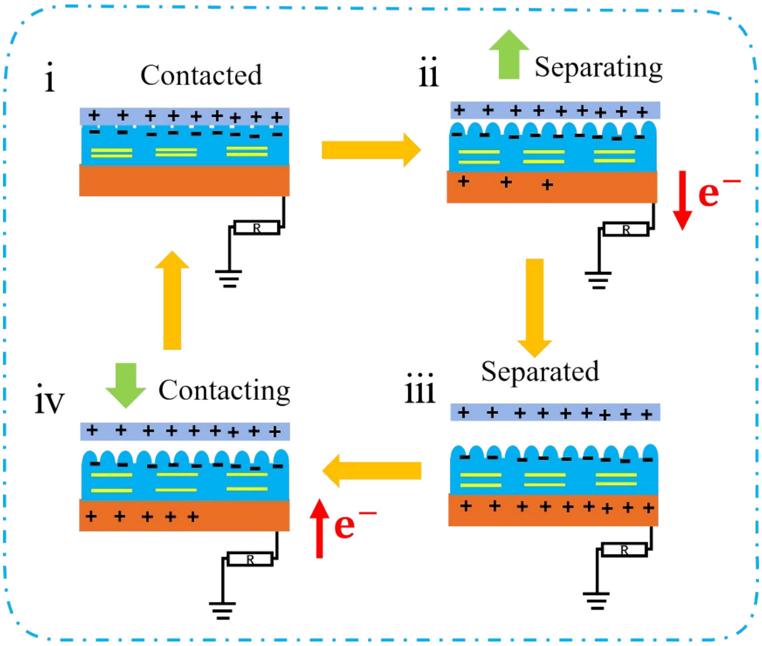

Fig. S6 Charge transfer process in a cycle

The microstructured PDMS/Ag NWs composite films (MSPS) prepared by constructing microstructures based on Ag NWs, PDMS, and sandpaper as templates synergize with each other to constitute the MSPS-TENG by the following mechanism. The working mechanism also satisfies the electron-electron cloud potential well model as follows. [1, 2] When MSPS and skin are in contact and friction, according to the surface state model of metal-polymer contact charging, [3] many charge exchanges between the skin and MSPS align the Fermi energy levels of the two materials, which form triboelectric charges on the MSPS. During periodic contact separation, the triboelectric charge on the MSPS induces periodic movement of free electrons on the electrodes and the ground electrode, which generates electron flow in the external circuit. In detail, when the skin is in contact with the MSPS, the electrostatic equilibrium is balanced due to the triboelectric effect, due to the increase in the capacitance of the MSPS, and due to the increase in the effective contact area of the microstructures, which results in an increase in the transfer of electrons from the surface of the skin to the surface of the MSPS microstructures as well (Fig. S6 i). When the skin is moved away, the electrostatic balance is broken, and the negative charge on the surface of the MSPS induces a positive charge on the Cu electrode, and therefore the electrons on the Cu electrode are moved to the ground through an external circuit, which generates a positive-direction output signal (Fig. S6 ii). When separated by a certain distance, electrostatic equilibrium is reached again (Fig. S6 iii). When an external force is applied to the MSPS-TENG, the electrostatic equilibrium is broken and electrons are transferred from the ground to the Cu electrode, thus generating a negative direction output signal (Fig. S6 iv).

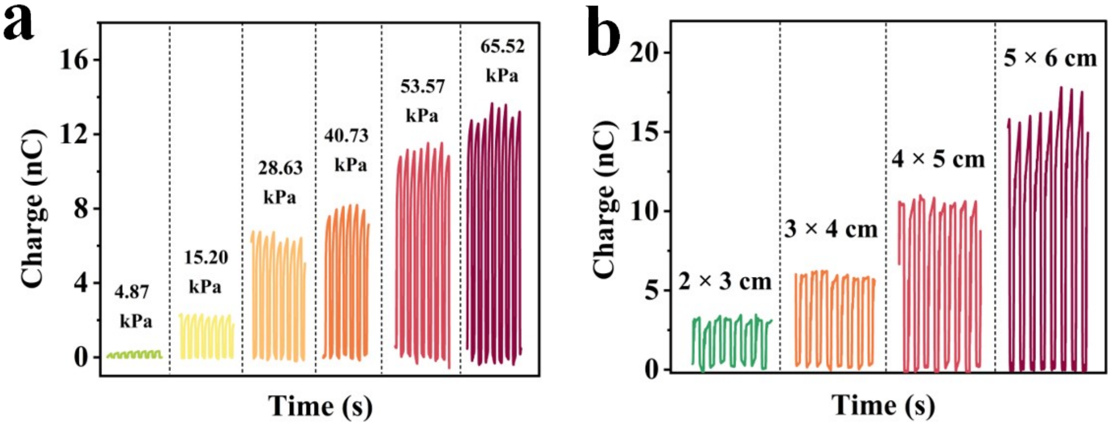

Fig. S7 (a) Qsc of MSPS-TENG with different pressures, (b) Qsc of MSPS-TENG with different sizes under the same conditions (1Hz, 53.57 kPa).

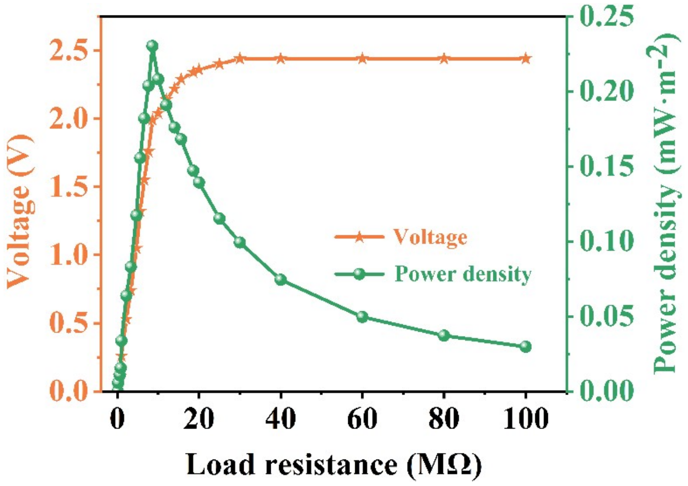

Fig. S8 Relationship between V_{oc} and power density of load resistance based on pure PDMS thin film TENGs.

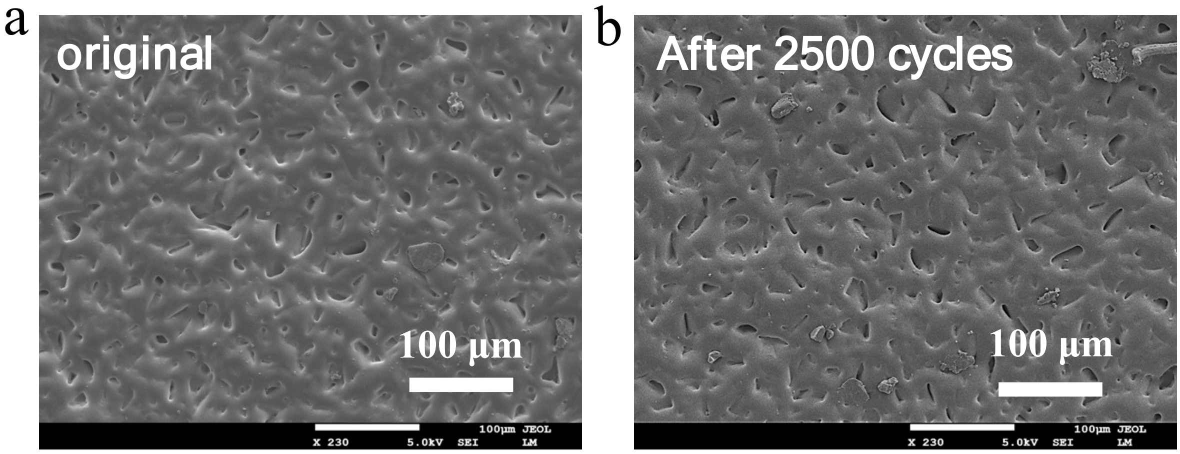

Fig. S9 (a) Surface structure of microstructure PDMS/Ag NWs thin films before cyclic testing. (b) Surface structure of microstructure PDMS/Ag NWs thin films after 2500 cycles of testing.

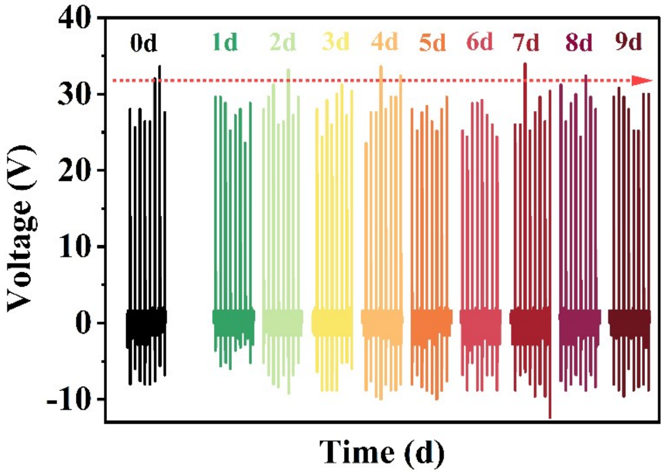

Fig. S10 MSPS-TENG open circuit voltage stability when submerged in water.

To test the stability of the TENG for long-term storage under high humidity conditions, the triboelectric material of the MSPS-TENG in this experiment was directly immersed in water. The test results are shown in **Fig. R11**. No significant fluctuations in the voltage output of the TENG device were observed over the nine days of the test to demonstrate the stability of the fabricated MSPS-TENG device under high humidity conditions.

References

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