ADVANCED MATERIALS

Supporting Information

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Freestanding Triboelectric-Layer Based Nanogenerators for Harvesting Energy from a Moving Object or Human Motion in Contact and Non-Contact Modes

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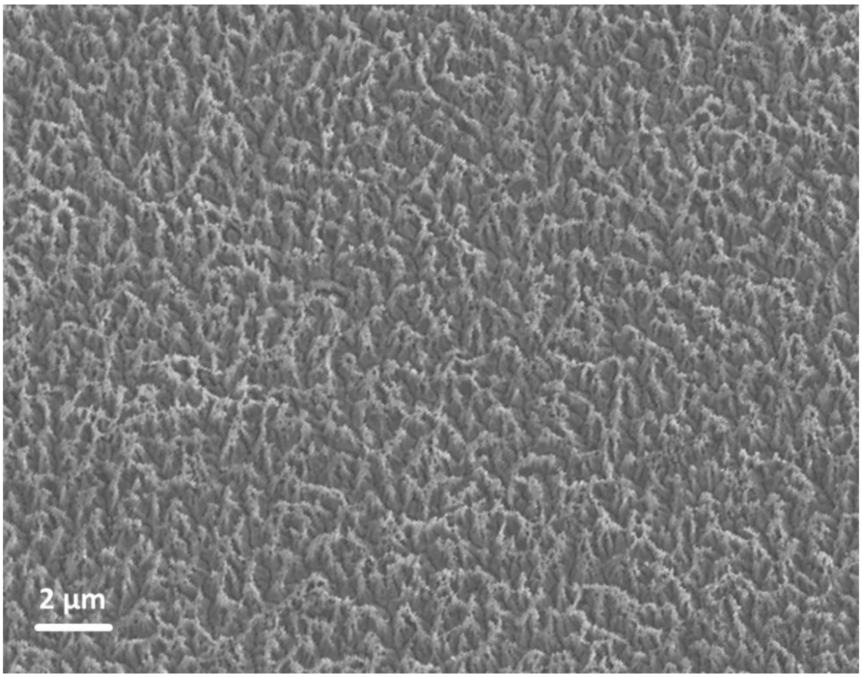

Figure S1. Scanning electron microscope (SEM) image of the nanorod structures on the surface of a piece of FEP film, which was created by ICP reactive ion etching.

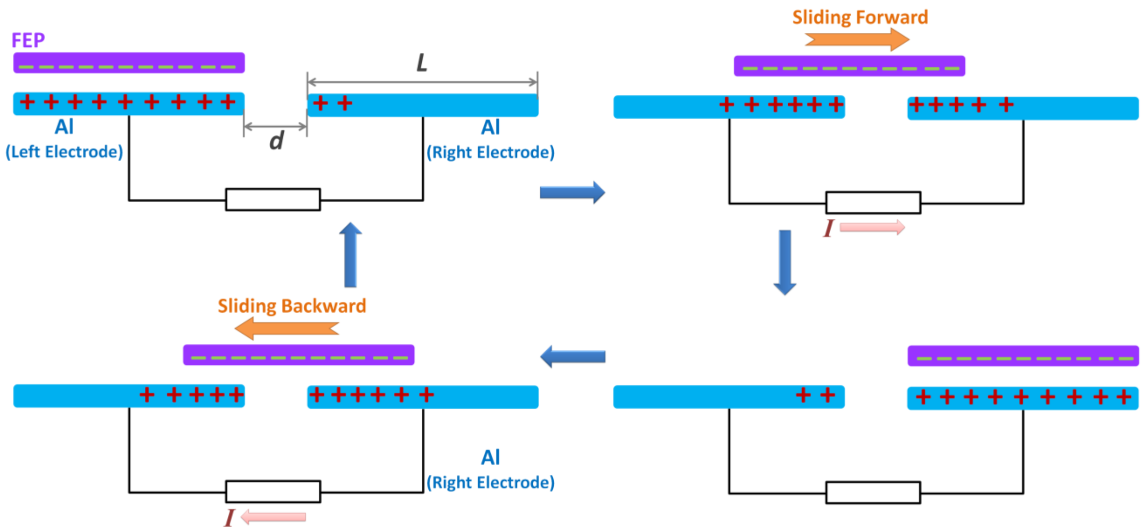

Figure. S2 The schematics showing the basic working principle of a conductor-to-dielectric FTENG in non-contact mode.

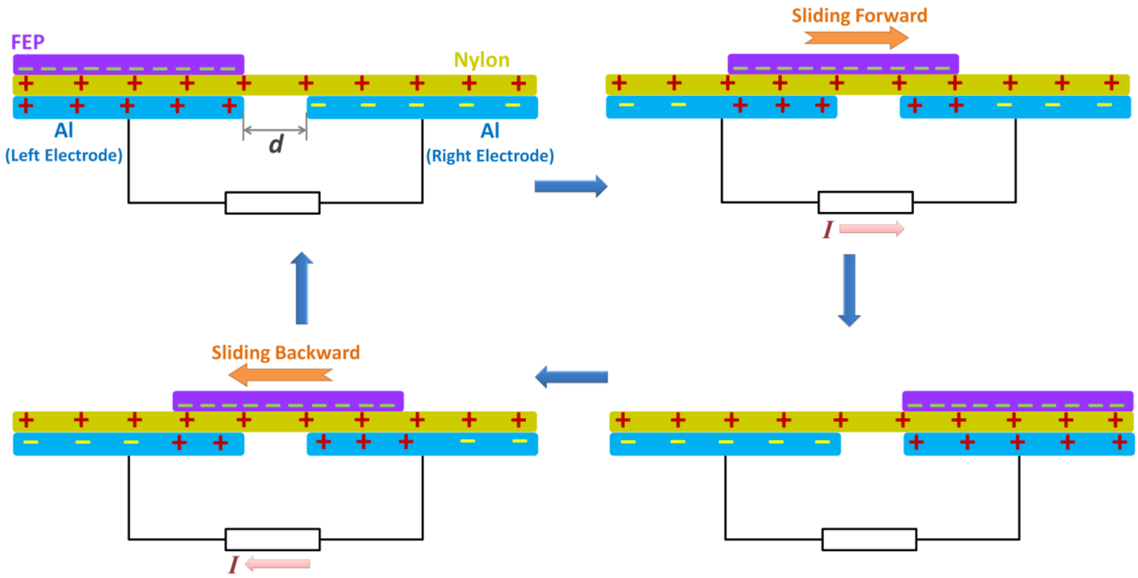

Figure S3. The schematics showing the basic working principle of a dielectric-to-dielectric FTENG.

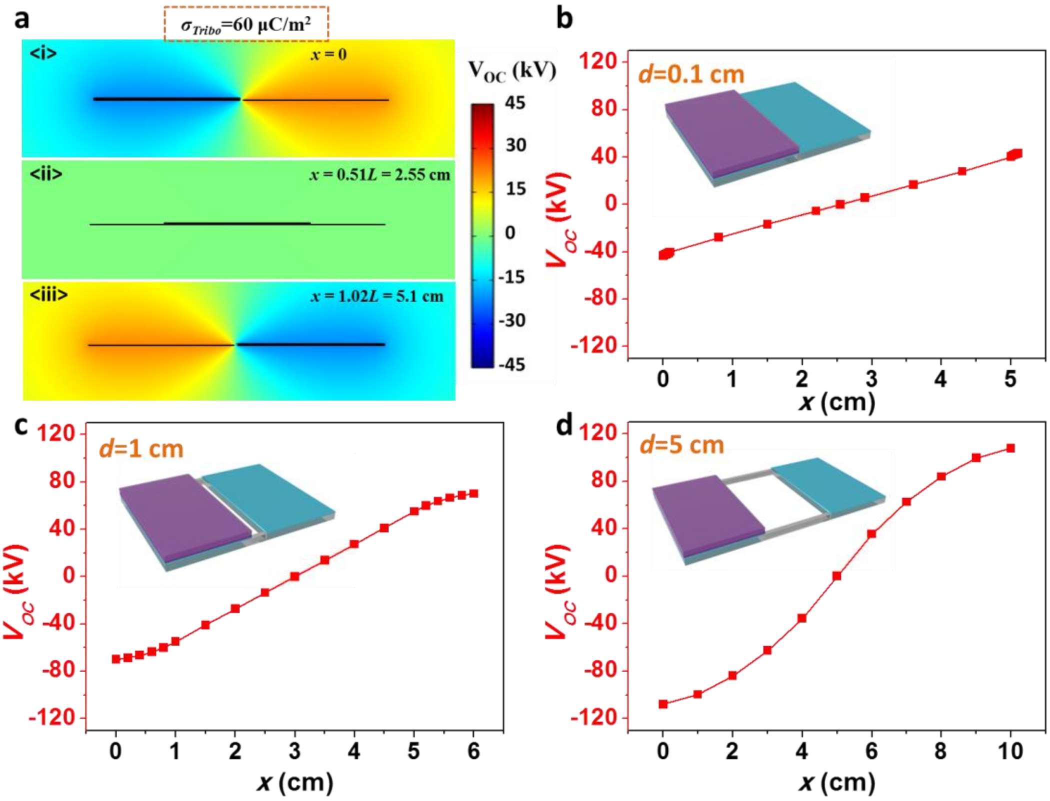

Figure S4. FEM simulation of the potential distributions and V_{OC} of the FTENG at different displacements (x). As the boundary condition, the positive charges are assumed to evenly distribute between those two electrodes. (a) The simulated potential distributions at three different sliding displacements (0, 2.55 cm and 5.1 cm) of a FTENG with an electrode length of 5 cm and an electrode distance of 0.1 cm. (b-d) The simulated open-circuit voltages (V_{OC}) at different sliding displacements (x) of 3 FTENGs with the same electrode size (L = 5 cm) but different electrode distances (d): (b) d = 0.1 cm; (c) d = 1 cm; (d) d = 5 cm. The insets are the schematics showing the corresponding FTENG structures.

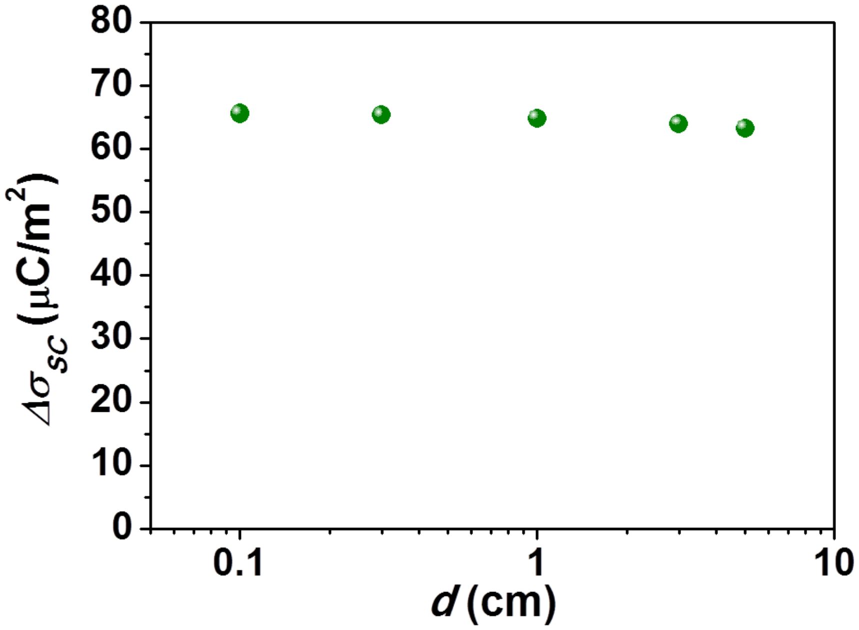

Figure S5. The transferred charge densities ($\Delta\sigma_{SC}$) from the five FTENGs with different electrode distances, obtained from the integrations of one current density peak in each corresponding group of J_{SC} data shown in Figure 3c.

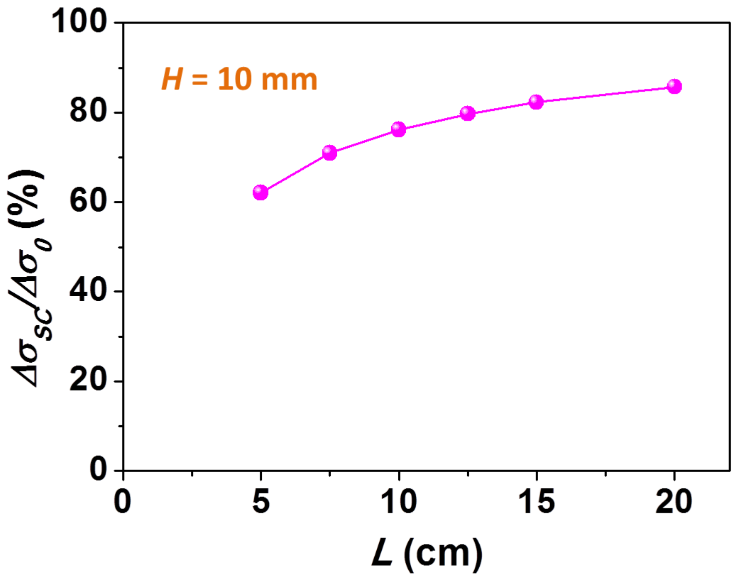

Figure S6. The FEM simulated ratio between the transferred charge densities ($\Delta\sigma_{SC}$) to the maximum transferred charge density in contact-sliding mode ($\Delta\sigma_0$) at the vertical separation (*H*) of 10 mm, which are obtained from six FTENGs with different electrode/freestanding-layer dimensions (*L*) from 5 cm to 20 cm. It clearly shows that when *L* increases, the transferred charge density at the same vertical separation distance will increase. This set of theoretical results indicates that a larger electrode/freestanding-layer dimension along the sliding direction will give a FTENG a better tolerance to the vertical separation.

Energy conversion efficiency of the FTENG in non-contact sliding mode

When the FTENG operates in non-contact mode, there is no friction between the FEP and the electrodes during the sliding process. Thus, no heat is generated. As a result, the input mechanical energy can only be converted to electric energy (E_{ele}) delivered to the load and the electrostatic potential energy (E_{ep}) in the FTENG device. Thus, the energy conversion efficiency of the FTENG in non-contact mode can be calculated by the following equation:

$$\eta = \frac{E_{ele}}{E_{ele} + E_{ep}} \times 100\%$$

As for the electrostatic potential energy stored in the FTENG device, it is determined by the charge distributions in the device. Since the structure of the FTENG is symmetric, the charge distributions at the two terminal states where the FET is at the overlapping position with either one of the electrodes should be fully symmetric, as shown by the schematic working principle in Figure S2. Thus, there should be no change in the electrostatic potential energy of the FTENG before and after a full sliding motion of the FEP from the one electrode to the other. Then, the electrostatic potential energy converted from input mechanical energy (E_{ep}) should be zero. This means all the mechanical energy can be converted to electric energy, so that an efficiency of 100% can be achieved by the FTENG in the non-contact mode.

Video S1. Electricity generated by the sliding of a human hand attached with a freestanding triboelectric layer.

Video S2. 100 LEDs instantaneously driven by a FTENG in non-contact sliding mode.

Video S3. FTENG for harvesting mechanical energy from the walking of different people