Supplemental Information

Biomimicking Hydrophobic Leaf Structure using Soft Lithography for Fog Harvesting, Triboelectric Nanogenerators as a Self-Powered Rain Sensor

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Transparent Methods

Leaf selection and preparation

Based on their micron-scale visible surface patterns, four different leaves were selected for this study: Arrowhead, Sanchezia, Banana, and Money Plant. Figure 1 shows the wettability, the presence of a waxy epicuticular layer, and the shape and size of their surface microstructures. The surface wettability of the selected leaves ranged from hydrophilic to superhydrophobic. The leaves are collected from the plants and used within thirty minutes to prevent excessive dehydration. Before use, the top surfaces of the leaves were carefully washed with purified water to remove any dirt particles during the sampling process, keeping away the leaf's primary veins or vascular systems to protect the mold surface as much as possible.

Contact angle measurement

The contact angle is where the droplet's boundary meets the solid surface. The contact angle between the droplet and the surface is a critical characteristic of the droplet's wetting behavior.

This study used the angle of contact measurements to analyze the surface wettability of four leaf types, as shown in Figure 4: Money Plant, Sanchezia, Arrowhead, and Banana. The contact angle determines a solid surface's wettability, showing its hydrophilicity or hydrophobicity. A drop of liquid (2µL) was carefully deposited on each leaf surface. The contact angle analyzer captured the droplet and analyzed the angle formed between it and the solid surface, providing information about the surface wettability of the leaf.

Water collection from Fog

Pure drinking water is in short supply in dry and desert areas, posing a severe problem for the local population. One possible solution to this issue is harvesting water from Fog. Several research groups have developed a variety of substrates with high water harvesting efficiency,

but a material with high reusability and flexibility is still needed. To understand the role of surface roughness in water collection, four leaves with various surface roughnesses were used for fog harvesting.

According to Wenzel's Equation, increasing the roughness of a surface increases its hydrophobicity. Increasing the roughness makes a hydrophilic surface more hydrophilic and a hydrophobic surface more hydrophobic. Using leaves to collect water from Fog is an innovative and environmentally friendly way to use the natural qualities of certain leaves to get water from foggy places. This technique is especially effective in areas with limited access to clean water, such as dry or hilly regions. Surface wettability greatly influences water collection efficiency, as discovered. Hydrophilic surfaces attract water, whereas hydrophobic surfaces resist it. Hence, four plants, such as Money Plant, Sanchezia, Arrowhead, and Banana leaves, were arranged to study fog harvesting.

Fabrication of Leaf-TENG

Due to environmental concerns, researchers are finding new ways to reuse and recycle plastic. This work used old plastic boxes to make the Leaf-TENG device in this work, as shown in Figure 7. The smooth and flat surface of the box was divided into two pieces, each measuring (7 x 3 cm). Two aluminum electrodes (2 x 1.5 cm) were attached to both sides of the plastic sheet substrate. A similar-sized Ecoflex sheet with a leaf pattern was placed under the aluminum electrode on one side of the device. After that, copper wires were attached to the electrodes for electrical connections, and both layers were securely attached on both sides, forming a Leaf-TENG device.

Electric measurements device

The open-circuit voltage and short-circuit current are measured with a digital storage oscilloscope (KEYSIGHT InfiniiVision DSOX2012A) and a Keithley Picoammeter (6485) to evaluate the device's efficiency.

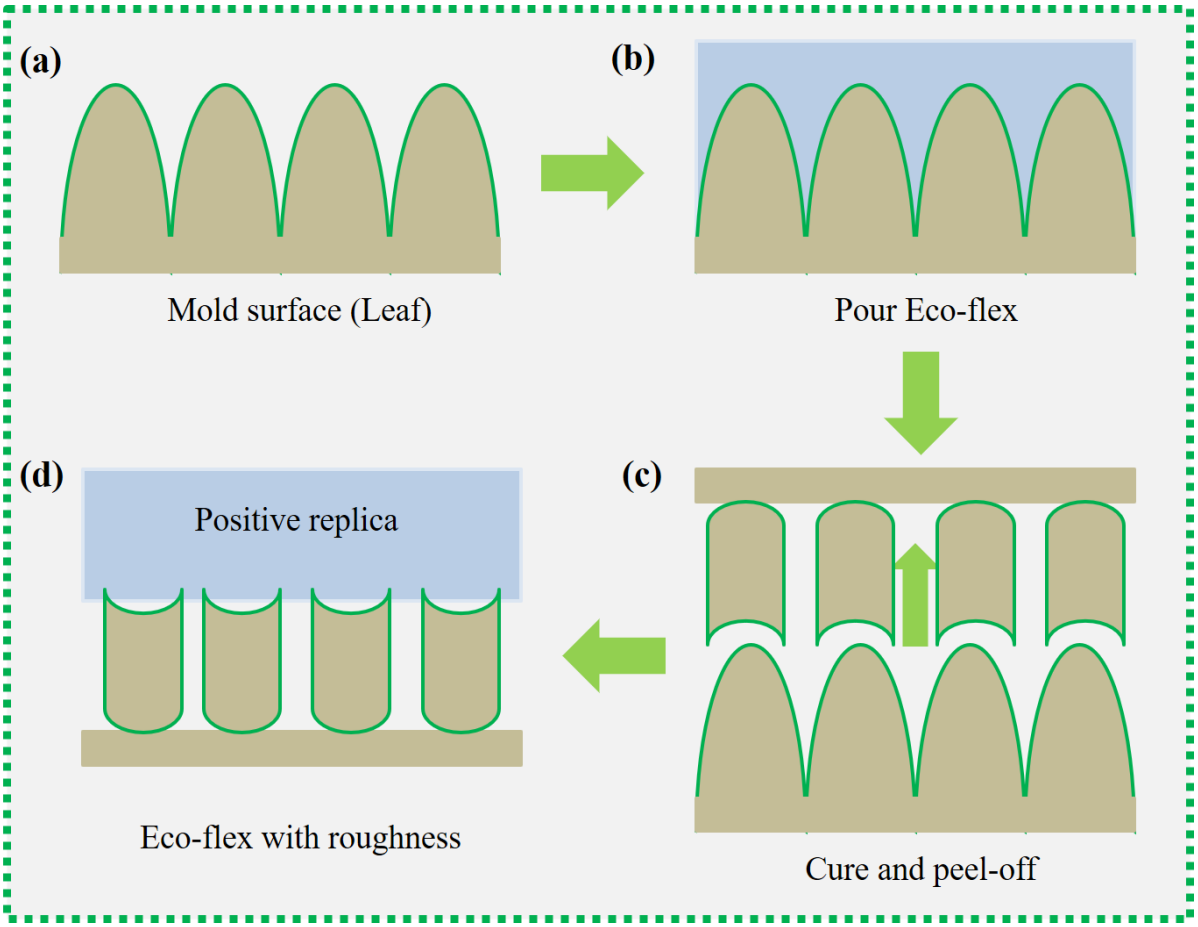

Figure S1. A soft lithography operation occurs on the surface of a leaf (Related to Figure 1).

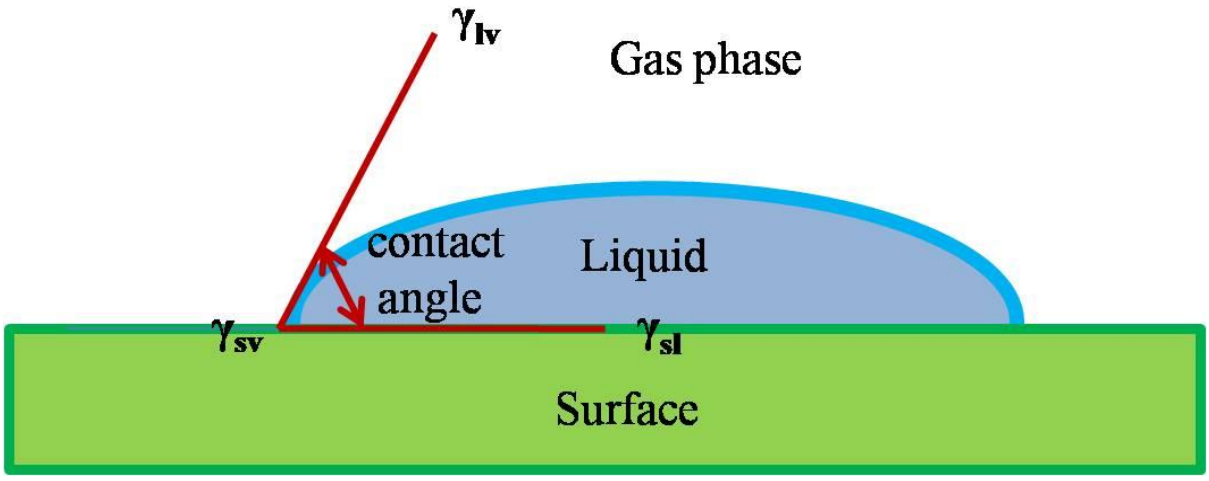

Figure S2. Three-phase boundary contact angle and interfacial tension (Related to Figure 4).

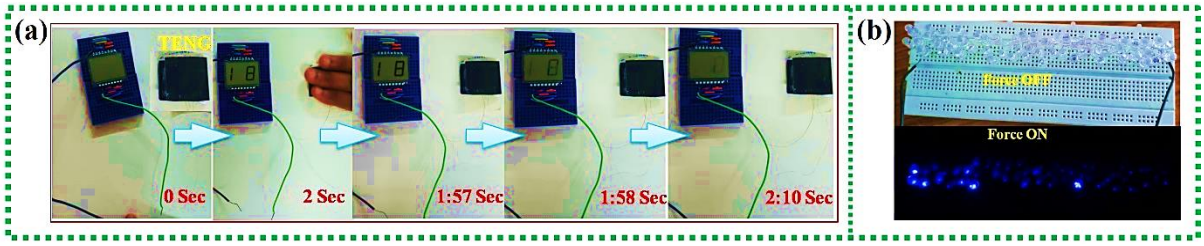

Figure S3. Leaf-TENG device powering the Lumex display and LEDs (Related to Figure 12).

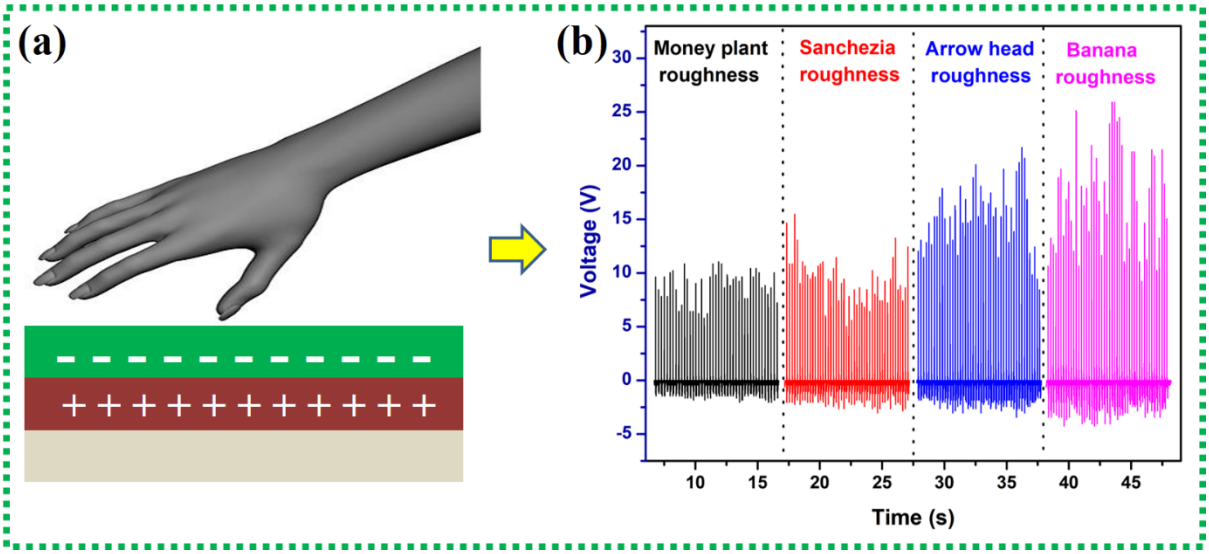

Figure S4. Leaf-TENG device using a single-electrode mode corresponding to the applied force (Related to Figure 13).

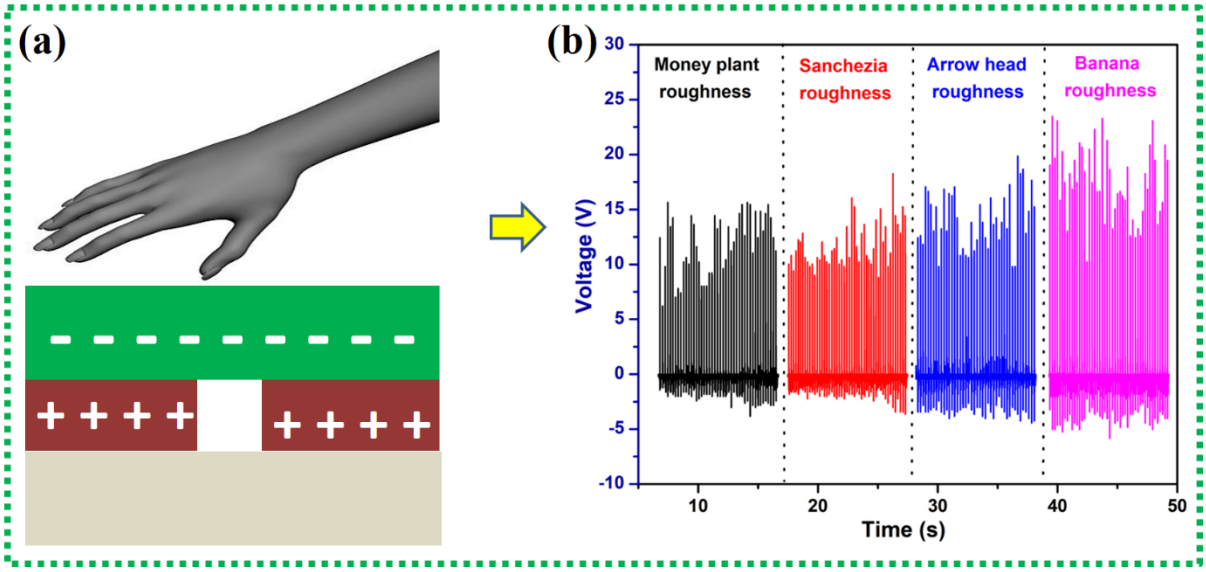

Figure S5. Leaf-TENG device using a freestanding triboelectric layer mode corresponding to the applied force (Related to Figure 14).

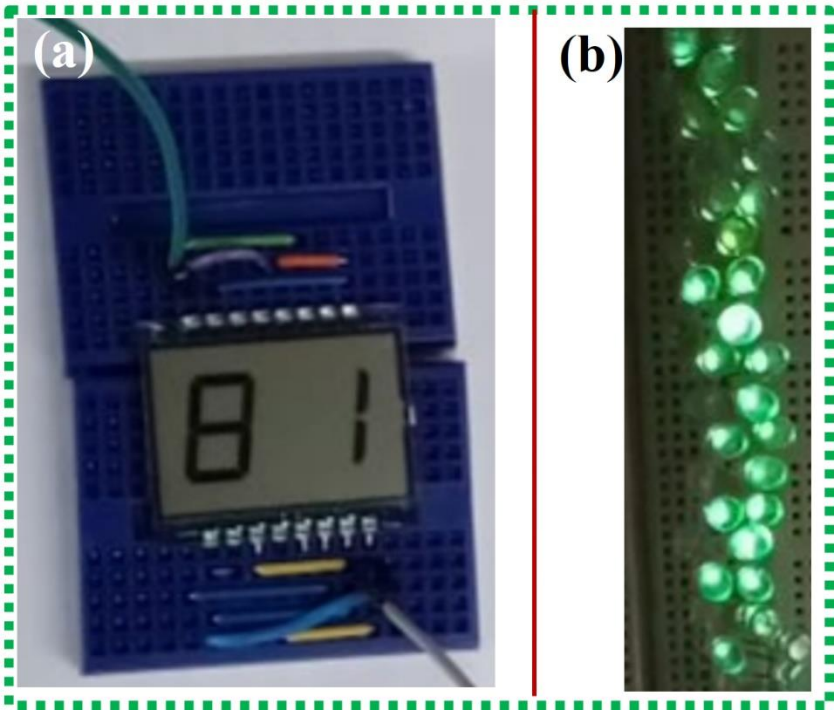

Figure S6. TENG device powering the Lumex display and LEDs (Related to Figure 13).

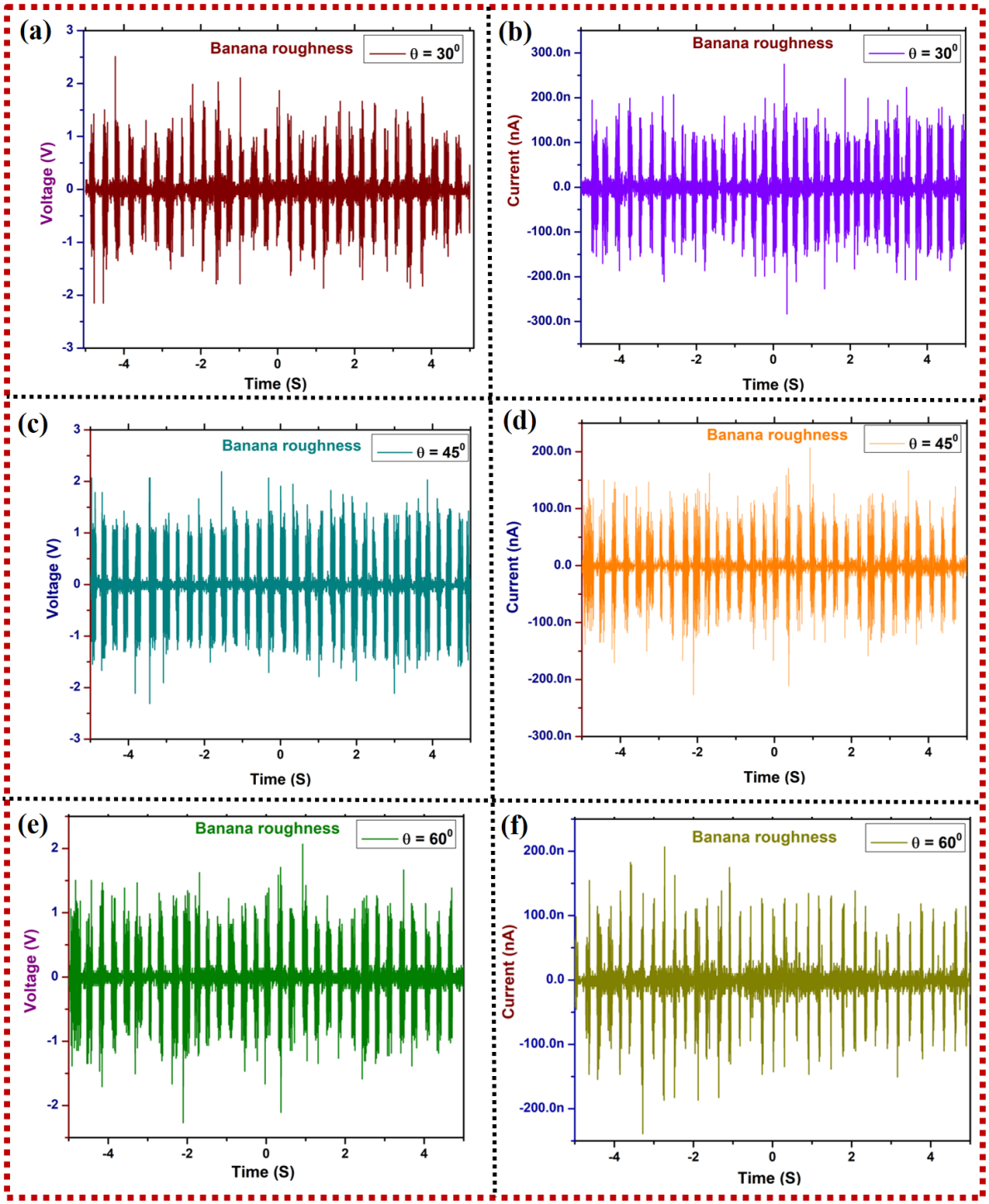

Figure S7. The voltage and current output when the angle of the polymer film is set to 30°, 45^0, and 60° angles (Related to Figure 13).

Supporting Videos List:

1. Video S1: Powering Lumex display (Related to Figure 12)

2. Video S2: Powering series connected to 18 LEDs (Related to Figure 12)

3. Video S3: Chess timer using Leaf-TENG (Related to Figure 12)

4. Video S4: Rain sensor TENG device using single electrode mode (Related to Figure 15)

5. Video S5: Powering Lumex display for single electrode mode (Related to Figure 13)

6. Video S6: Powering series connected to 20 LEDs for single electrode mode (Related to Figure 13)