Supplementary Information

Robust Reverse-Electrowetting Based Energy Harvesting on Slippery Surface

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(a) (b)

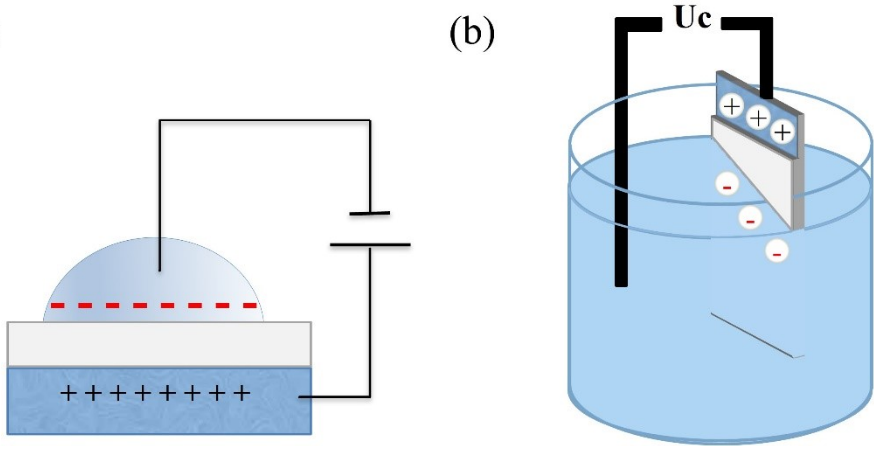

Figure S1. Experimental principle and schematic diagram of charge trapping (a) charge trapping principle, (b) schematic diagram of charge trapping.

The charge capture zone should be the entire surface of the sample, and the charge should be uniformly caught. Because the three-phase contact line is a straight line, the sample is immersed into the container uniformly so that all the surface is completed charge trapped.

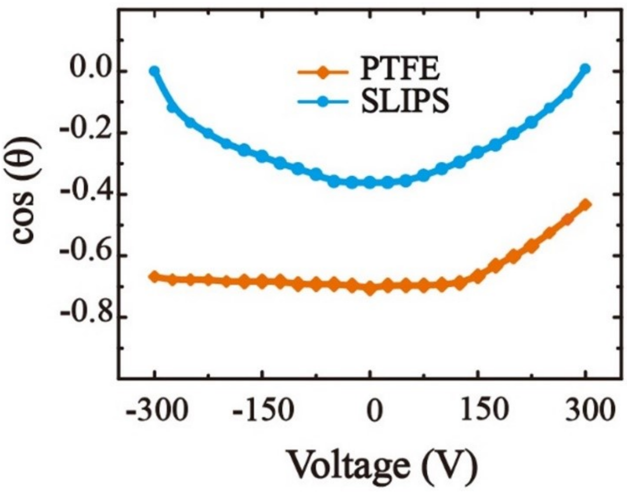

Figure S2. Charge trapping test: electrowetting curve of SLIPS and PTFE.

The presence of trapped charge on the surface of the dielectric layer results in the electrowetting equation satisfying the optimized Young-Lippmann equation[1]:

$$\cos\theta_v = cos\theta_Y + \frac{\varepsilon_0\varepsilon_r}{2d\gamma}(U - U_T)^2 \quad (1)$$

$$\sigma_T = \frac{\varepsilon_0\varepsilon_r U_T}{d} \quad (2)$$

where ε_0 is the vacuum dielectric constant, ε_r and d represent the dielectric constant and thickness of the insulating dielectric layer, respectively. Under the action of the electrowetting force, the contact angle of the droplet decreases from the initial contact angle θ_Y, and finally the system reaches a new equilibrium state, where the contact angle of the droplet is θv, U_T is the potential difference generated by the trapped charge, and σ_T is the density of the trapped charge. Following the electrowetting experiment, the experimental data was fitted using the electrowetting equation (1), thus U_T was obtained, and the positive and negative values of U_T represented the polarity of the trapped charge. The SLIPS is −63.33 V. The PTFE is −223.24 V. Then the charge entrapment is −0.059 mC/m^2 for SLIPS and −0.208 mC/m^2 for PTFE according to formula (2).

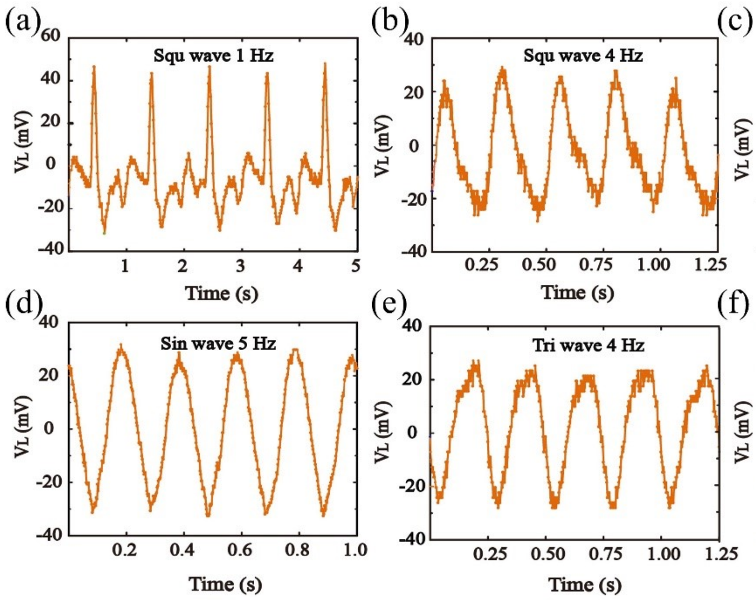

Figure S3. The instantaneous voltage output on the load V_L response to the form (square, sine and triangular) and frequency of the driving waveform applied on vibrator. For all graphs the droplet volume is 10 μL with oscillation amplitude L = 1.2 mm, R_L = 10 MΩ and bias voltage V = 20 V.

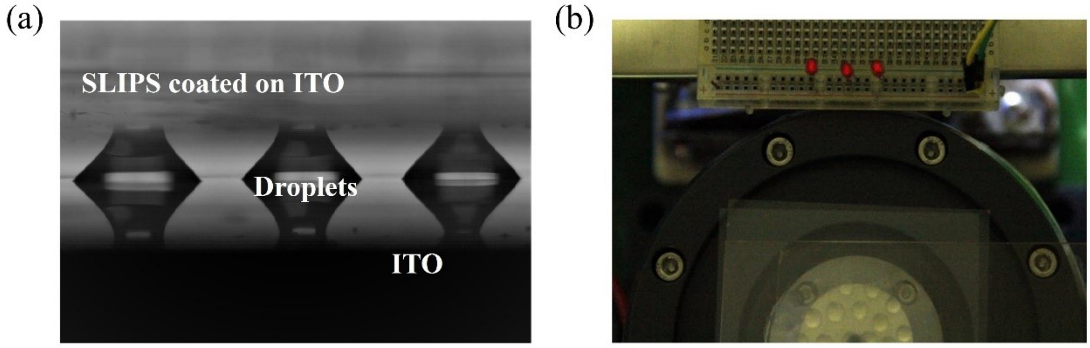

Figure S4. Application of REWOD-DEG based on SLIPS. (a) Experimental setup for enhanced power generation, (b) LEDs are lit up using 30 bridges for a sinusoidal input with f = 30 Hz，bias voltage V= 200 V. Total volume of droplets is about 300 μL. The threshold voltage of the red LED is 1.8 V.

Through experiments, we demonstrate that the power output of a single droplet is more than 100 nW, therefore we need to think about increasing the power output to drive the device. Obviously, in REWOD-DEG, it can be improved by increasing the bias voltage and the contact area between the conducting droplet and the dielectric layer. Therefore, we use the droplet array to generate electricity while increasing the bias voltage.

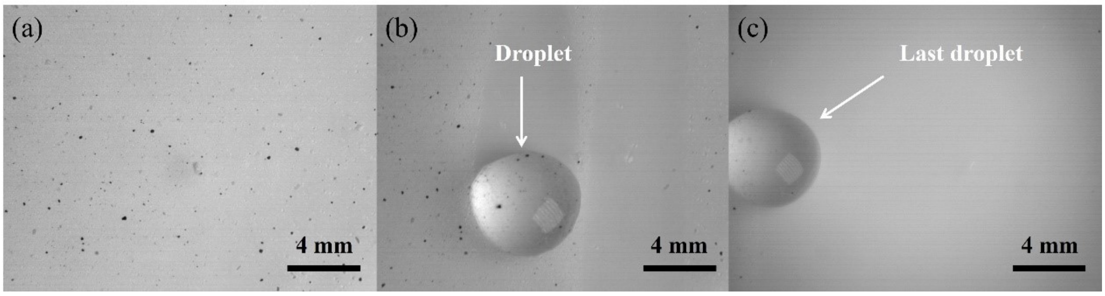

Figure S5. Self-cleaning property. (a) SLIPS is polluted with colored dust, (b) the droplet sliding cleans the surface, (c) SLIPS restore clean surface.

The fully hydrophobic nature of our SLIPS also helps protect the surface from various particulate contaminants, allowing for self-cleaning through a variety of fluids that collect and remove particles from the surface.

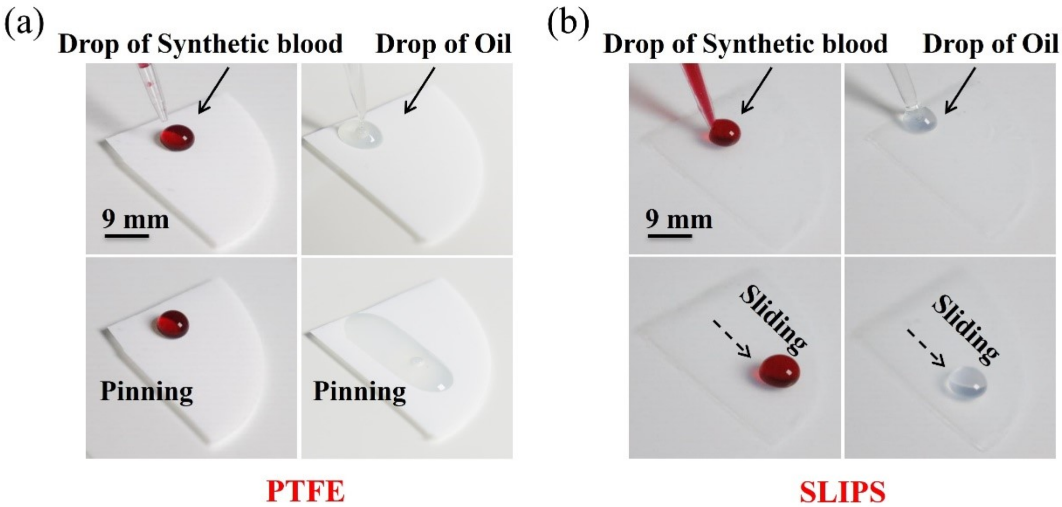

Figure S6. Repellency of complex fluids by SLIPS. (a) artificial blood and canola oil showed pinning phenomenon on PTFE surface, (b) artificial blood and canola oil slide across SLIPS.

In addition to repelling pure forms of liquid, SLIPS are also effective at repelling complex fluids, such as blood and canola oil, which quickly moisten and stain most existing surfaces.

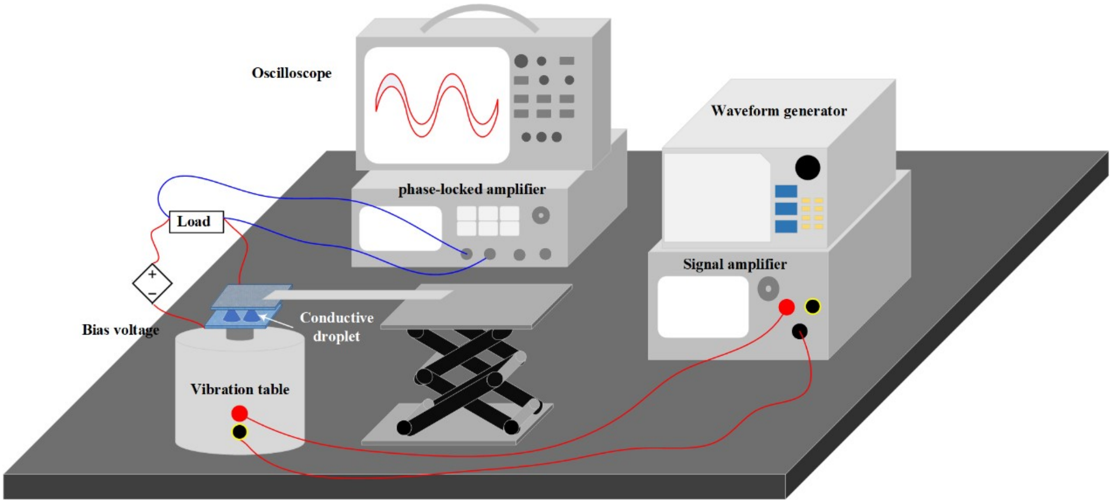

Figure S7. Schematic diagram of experimental setup for vibration mechanical energy harvesting based on REWOD-DEG

REFERENCES

1. Verheijen HJJ, Prins MWJ. Reversible electrowetting and trapping of charge: model and experiments. *Langmuir*. 1999;15:6616-6620.