Supporting Information

Self-Powered Droplet Manipulation System for Microfluidics Based on Triboelectric Nanogenerator Harvesting Rotary Energy

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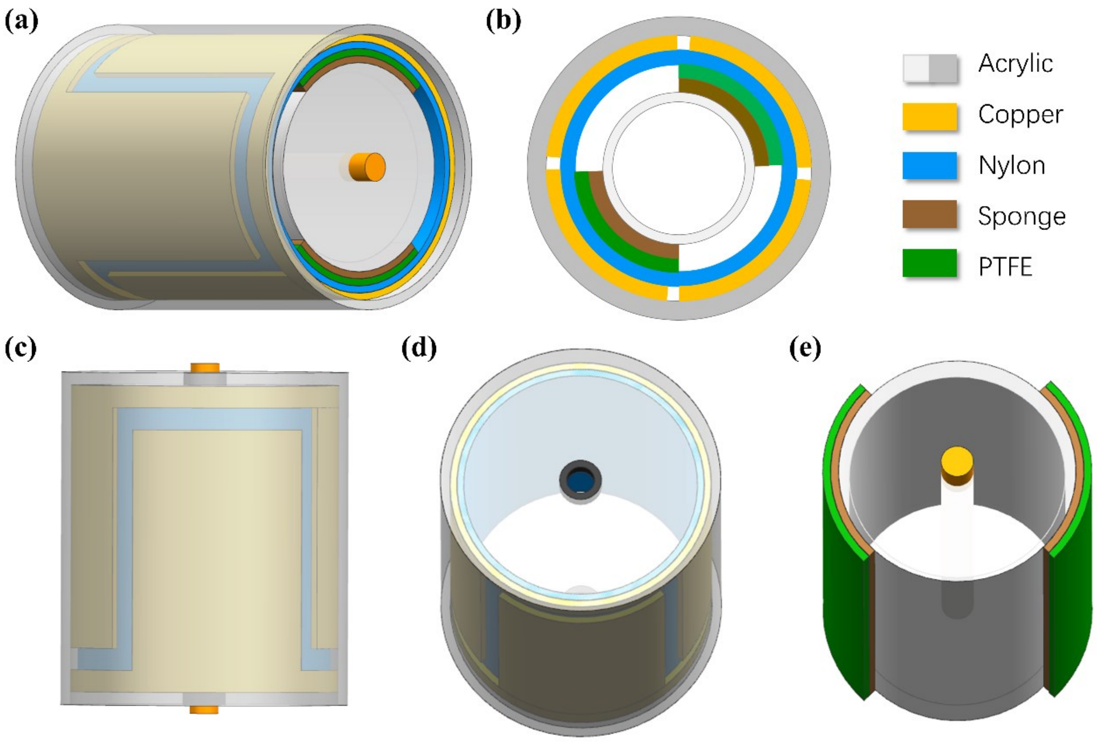

Fig. S1. (a) Structural design of rotating freestanding TENG. (b) Cross-sectional image of TENG. (c) Front view of TENG. (d) External stator. (e) Internal rotor.

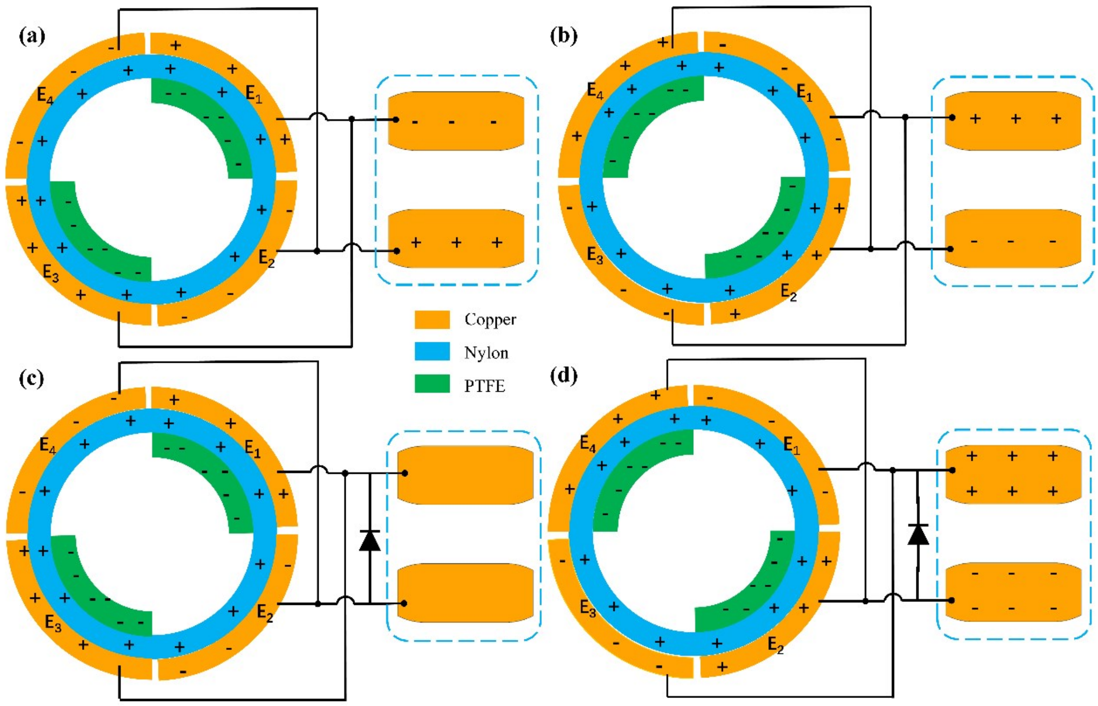

Fig. S2. Charge distribution of TENG and microfluidic devices without diode when PTFE moves to the counterpart position of electrode E_1 and E_3 (a) or electrode E_2 and E_4 (b). Charge distribution of TENG and microfluidic devices with diode when PTFE moves to the counterpart position of electrode E_1 and E_3 (c) or electrode E_2 and E_4 (d).

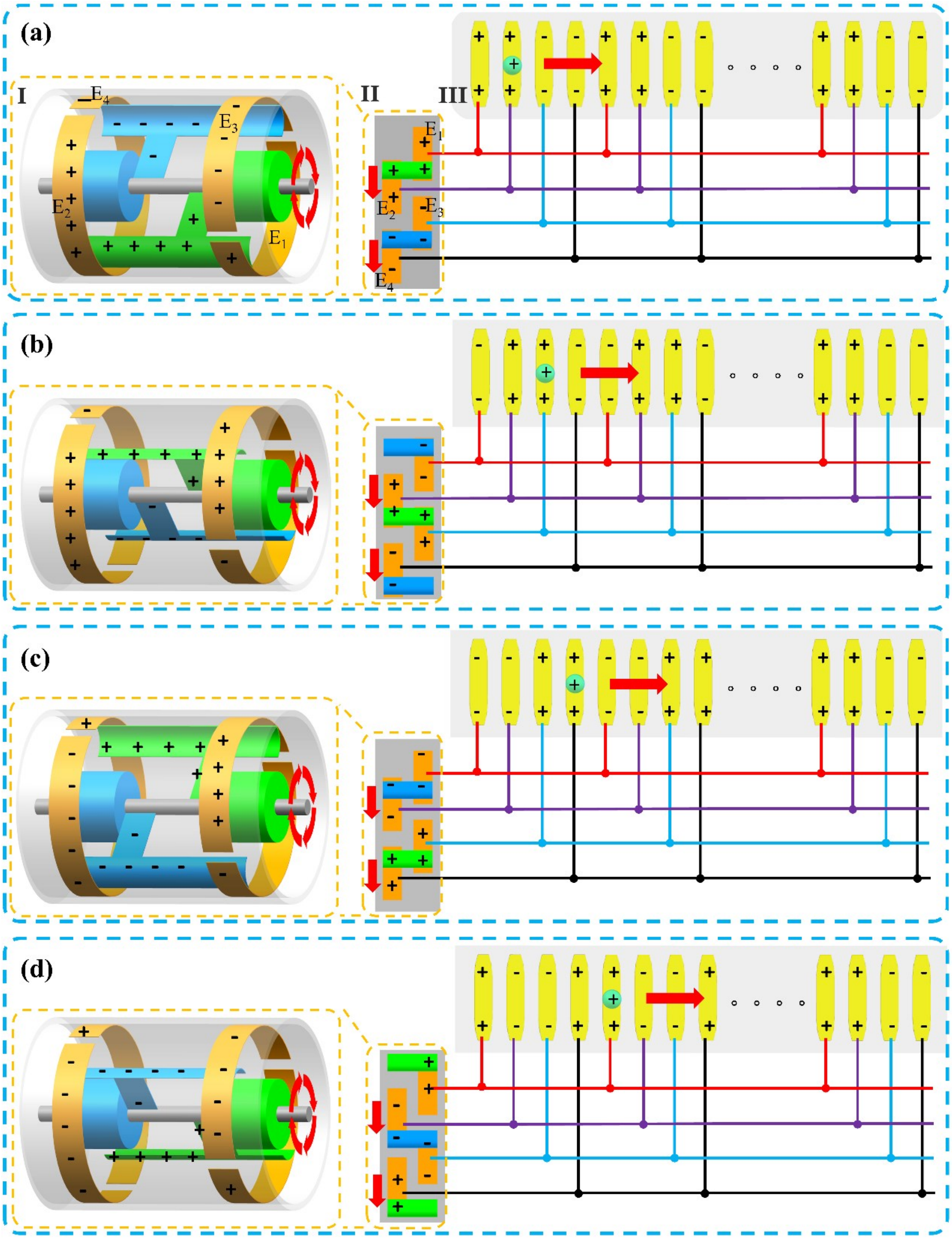

Fig. S3. Working principle of long-distance movement of droplet controlled by electric brush.

Fig.S3a (I) shows the electric brush of the T-SDMS, which is connected to the TENG through the diode. The two sliding electrodes of the electric brush are respectively charged positively and negatively. The red arrows indicate the direction of rotation of the sliding electrode. Fig.S3a (II) shows the flat view of the electric brush. The two sliding electrodes move down and are connected to the four fixed electrodes (yellow) in sequence, and charge transfer occurs, so that the fixed electrodes sequentially carry different charges. Fig.S3a (III) shows the microfluidic device of the T-SDMS. The four fixed electrodes of the electric brush are connected to the microfluidic device so that the electrodes on the microfluidic device are charged with different charges to generate an electric field and drive the droplets to move. As shown in Fig. S3 a-b, when the electric brush rotates a quarter of one cycle, the induced charge on the track electrodes will change, and the charge polarity of the electrode array moves the distance of one electrode to the right. As shown in Fig. S3 a-d, when the electric brush rotates one cycle, the charge polarity of the electrode array will move the distance of four electrodes to the right, and the charge of each electrode is the same as the original. However, the droplet will gradually move the distance of four electrodes to the right due to the Coulomb force.

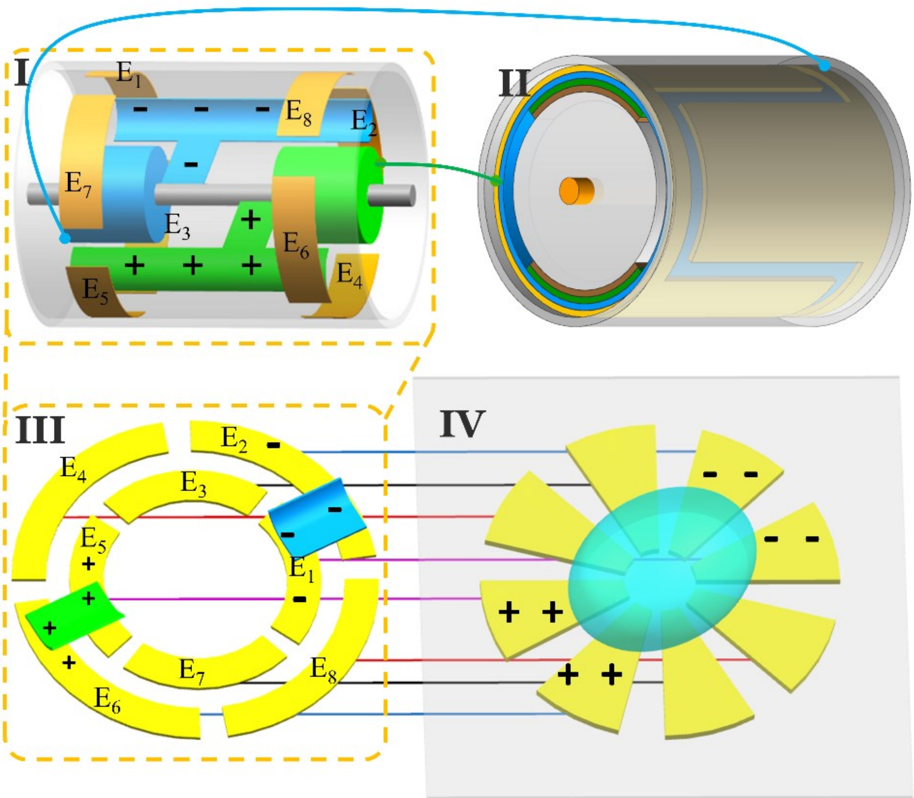

Figure S4. Schematic diagram of the self-powered droplet manipulation system for mixing.

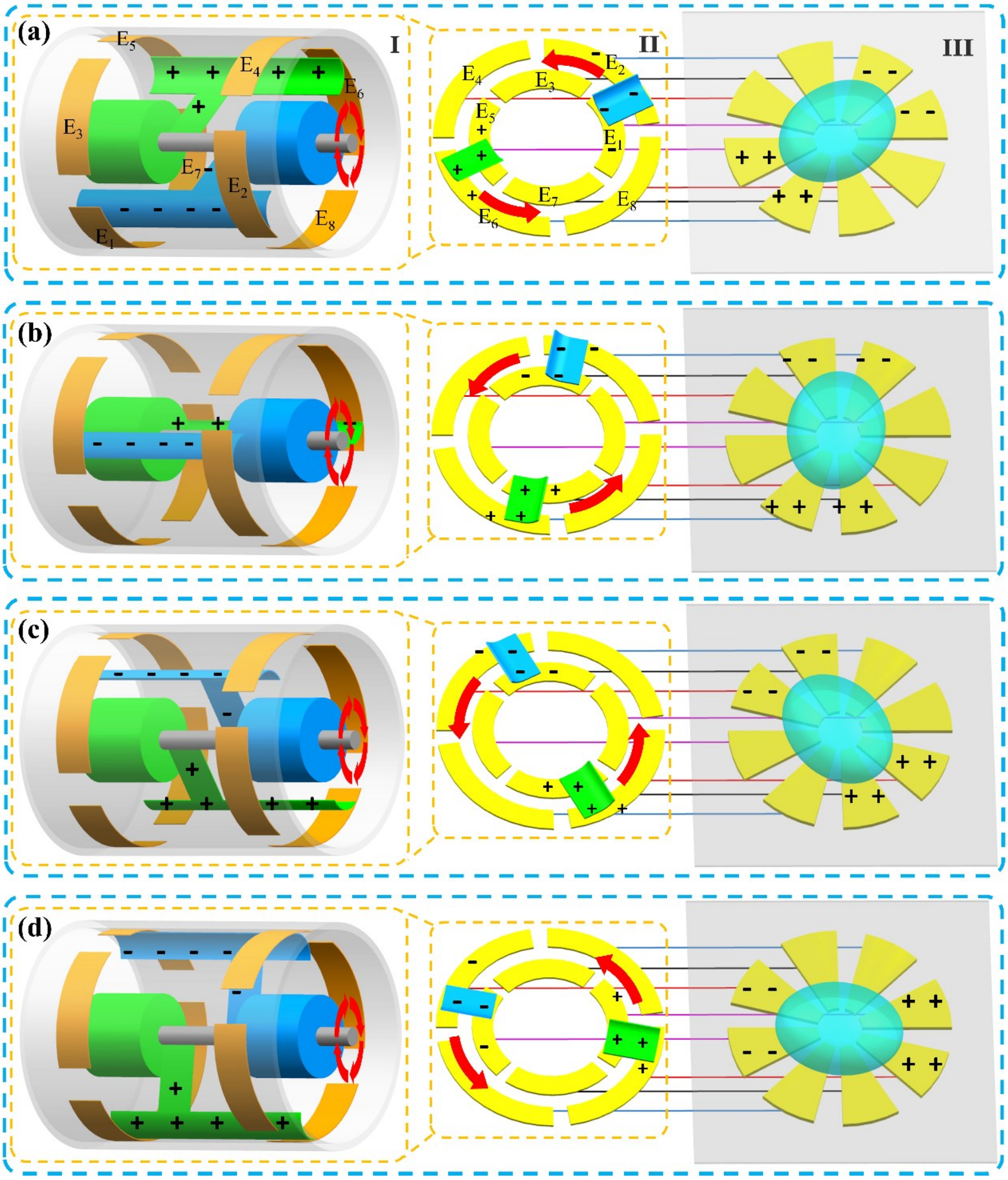

Figure S5. Working principle of mixing of droplets manipulated by electric brush.

Fig.S5a (I) shows the electric brush of the M-SDMS, which is directly connected to the TENG. The two sliding electrodes of the electric brush have different charges. Fig.S5a (II) shows the flat view of the electric brush, and two sliding electrodes move counterclockwise. Fig.S5a (III) shows the microfluidic device of the M-SDMS. The electrodes of the microfluidic device are respectively connected with the fixed electrodes of the electric brush. Part of the electrodes of the microfluidic device are charged, generating a non-uniform electric field, and the droplets are elongated. As shown in Fig.S5 a-d, when the electric brush is rotated, the charging of the electrode changes and the droplets are elongated in different directions.

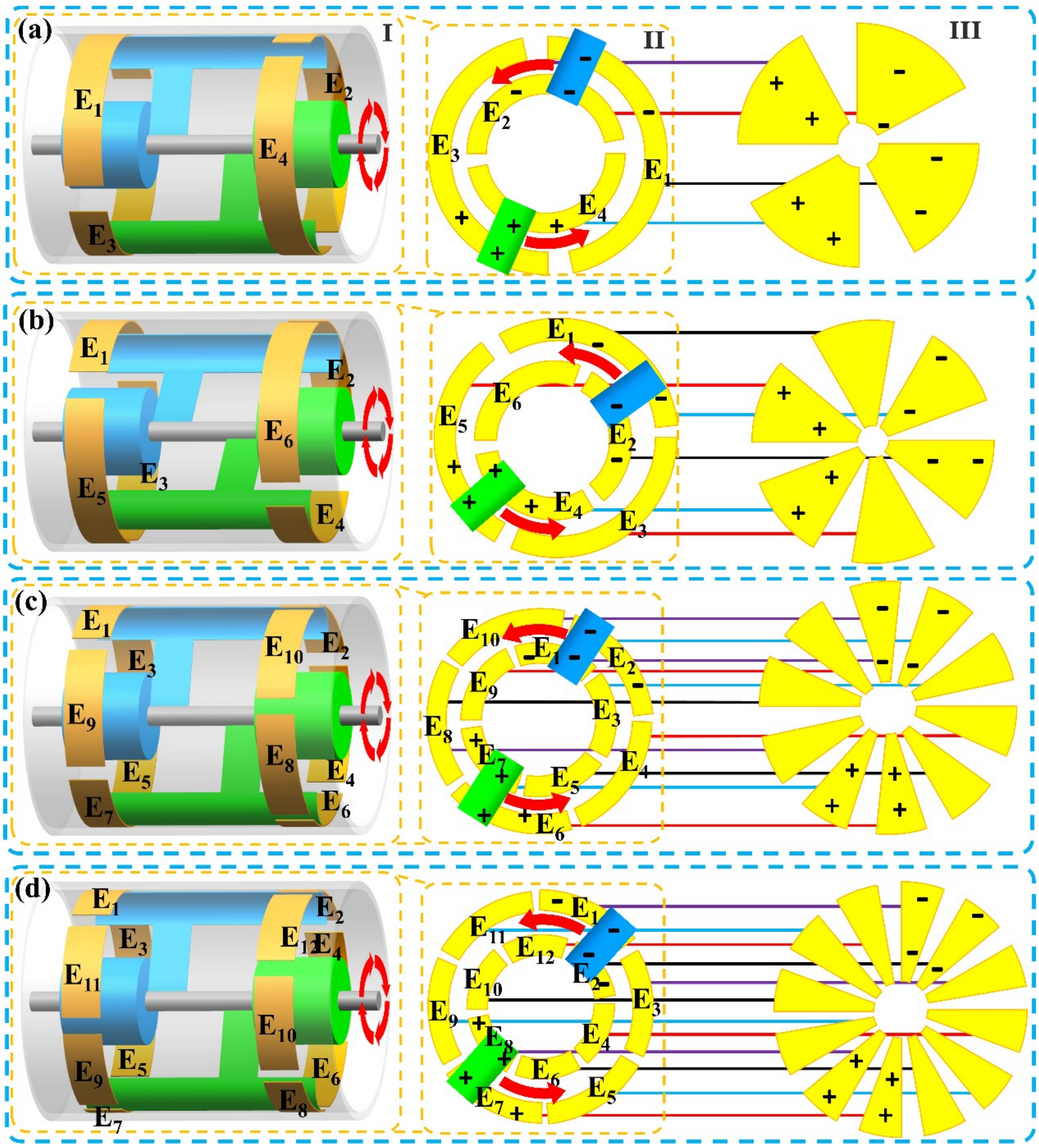

Fig. S6. Schematic diagram of microfluidic devices with different numbers of electrodes and electric brushes in self-powered droplet manipulation system for mixing. (a) Four electrodes. (b) Six electrodes. (c) Ten electrodes. (d) Twelve electrodes.

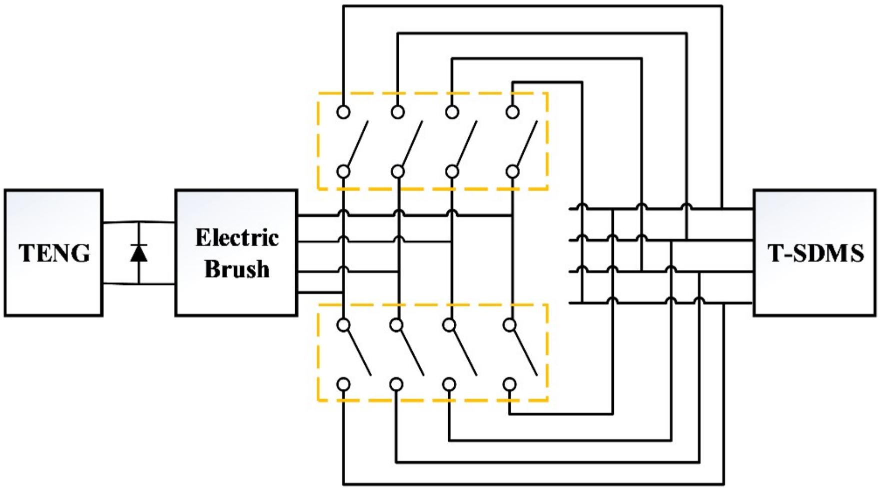

Figure S7. Schematic diagram of the circuit to manipulate reciprocating motion of the droplet