Supporting Information

Multiscale Surface Modified Magneto-mechano-triboelectric Nanogenerator Enabled by Eco-friendly NaCl Imprinting Stamp for Self-powered IoT Applications

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Keywords: Self-powered electronics, Magneto-mechano-triboelectric nanogenerator, micro- and nano-structures, IoT sensor

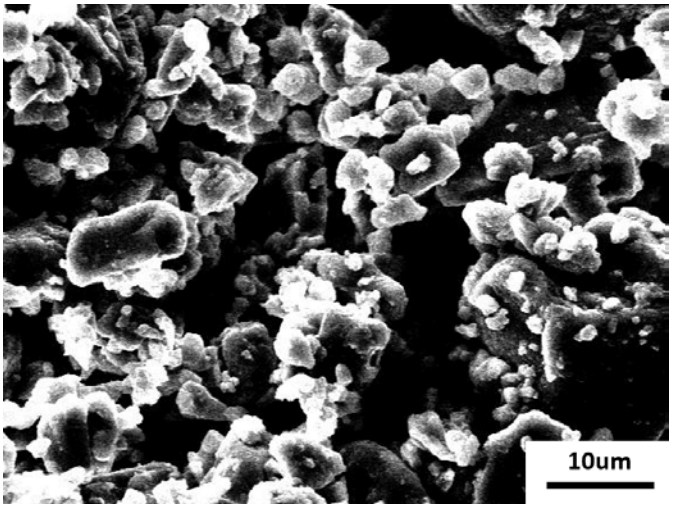

Fig. S1. SEM image of NaCl particles after planetary mill at 150 rpm for 10 h.

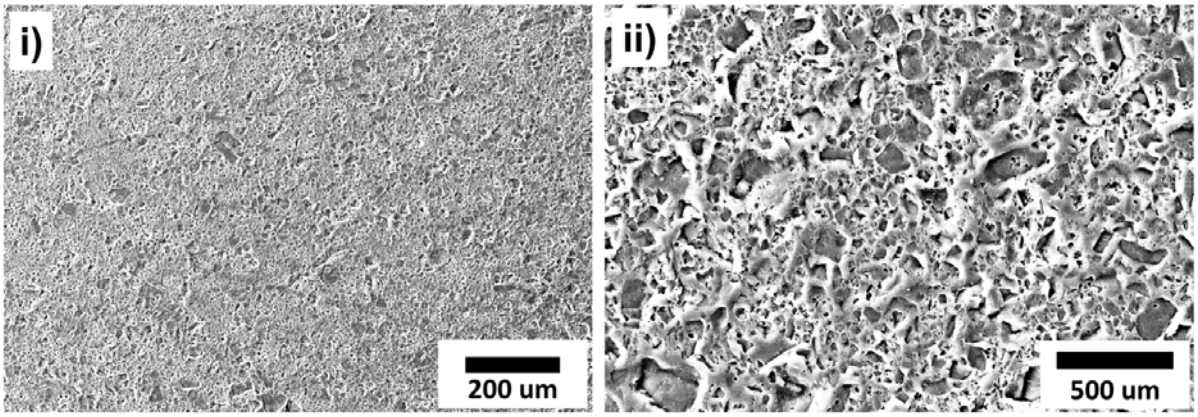

Fig. S2. SEM images of multiscale structures on PFA surface with different magnification of 100X (i) and 500X (ii).

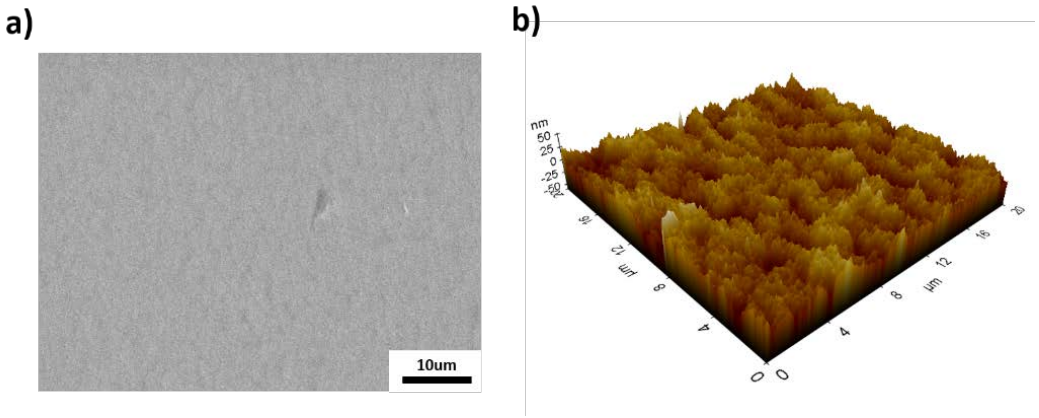

Fig. S3. (a) SEM image of the PFA surface before salt particle imprinting process. (b) 3D AFM image of the PFA surface before salt particle imprinting process.

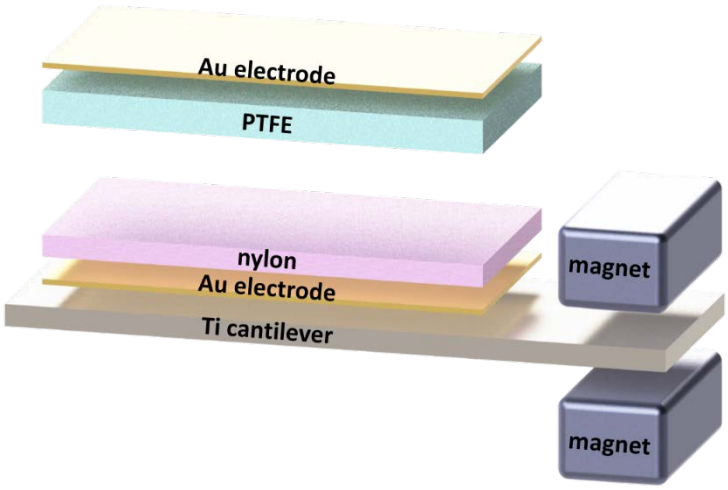

Fig. S4. Schematic diagram of MMTENG device with exploded view.

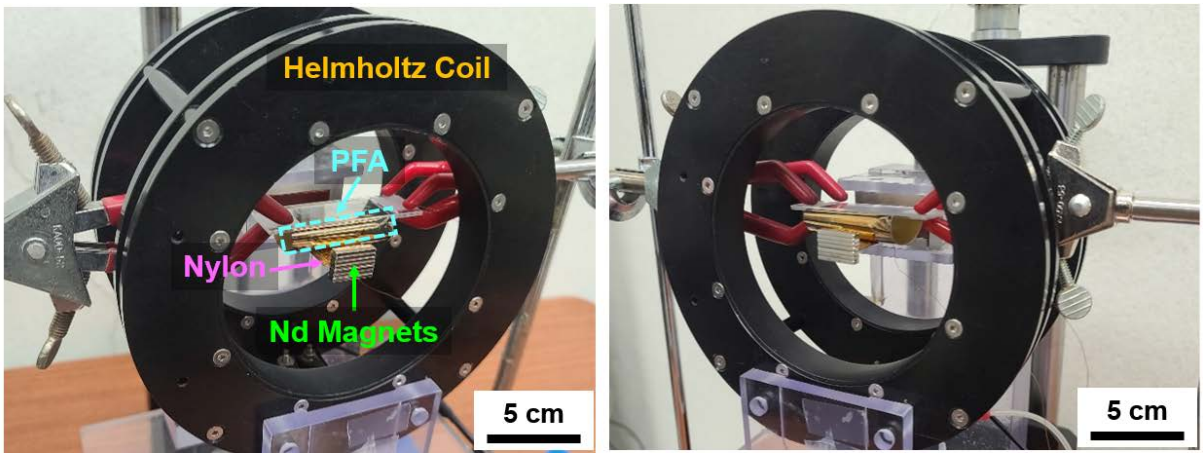

Fig. S5. Photo images of MMTENG system with different angle views.

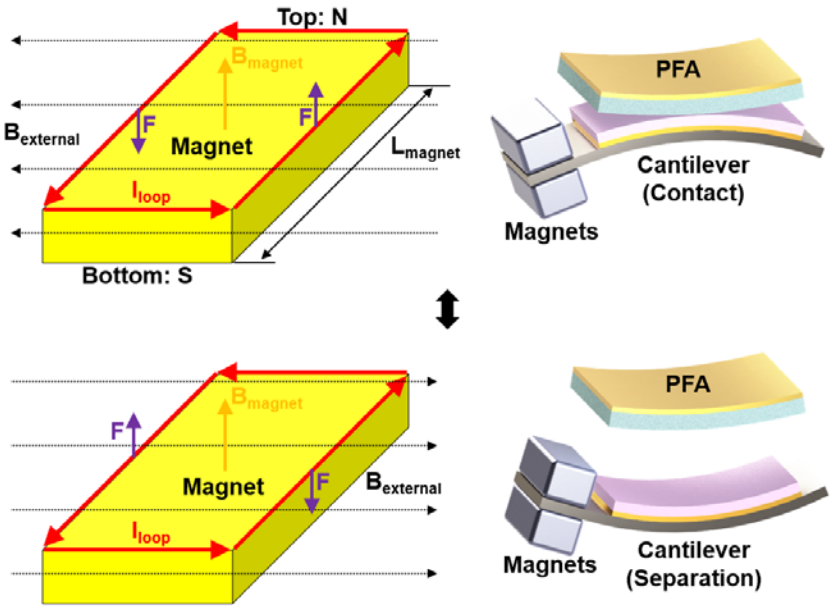

Figure S6. Schematic for working mechanism of MMTENG device with counterclockwise and clockwise toque on magnet under external AC magnetic field.

A mass magnet induces a magnetic field (B_{magnet}) upward, and we can consider that counterclockwise electric current (I_{loop}) is flowed *via* virtual loop in the magnet. When the AC magnetic field ($B_{external}$) is applied from the right to the left, the two length sides of mass magnet can be applied by forces (F) with opposite directions. Note that the direction of force is defined by Fleming's left-hand rule. The F is calculated by an equation of $F = B_{external} \times I_{loop} \times L_{magnet}$. The opposite forces on the two length sides in mass magnet derive counterclockwise torque, thus resulting in vibration of magnet attached cantilever. Subsequently, the direction of external magnetic field is changed toward right from left, which make torque with clockwise direction. Finally, the external AC magnetic field facilitates periodic up and down bending vibrations of MMTENG device.

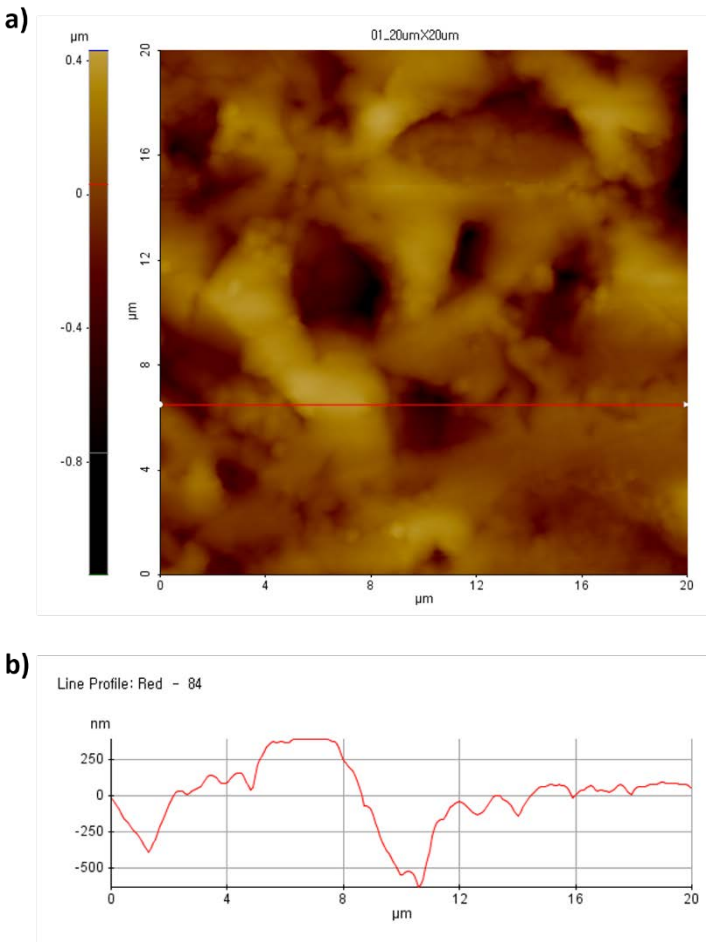

Fig. S7. (a) 2D AFM image of the PFA surface after salt particle imprinting process. (b) line profiling data of PFA surface for the red line on Figure S5 (a).

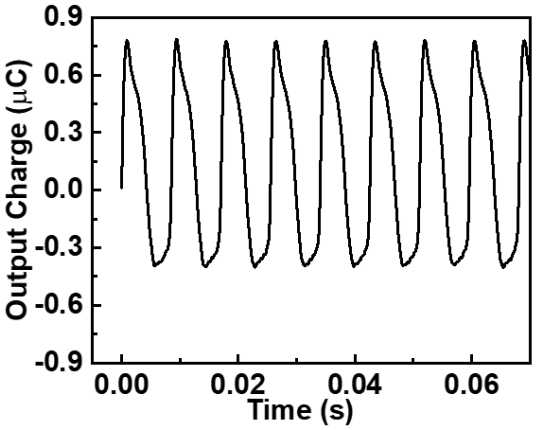

Fig. S8. Output charge curve generated from MMTENG at AC magnetic field of 8 Oe, which was measured by a charge meter (Type 5015, Kistler).

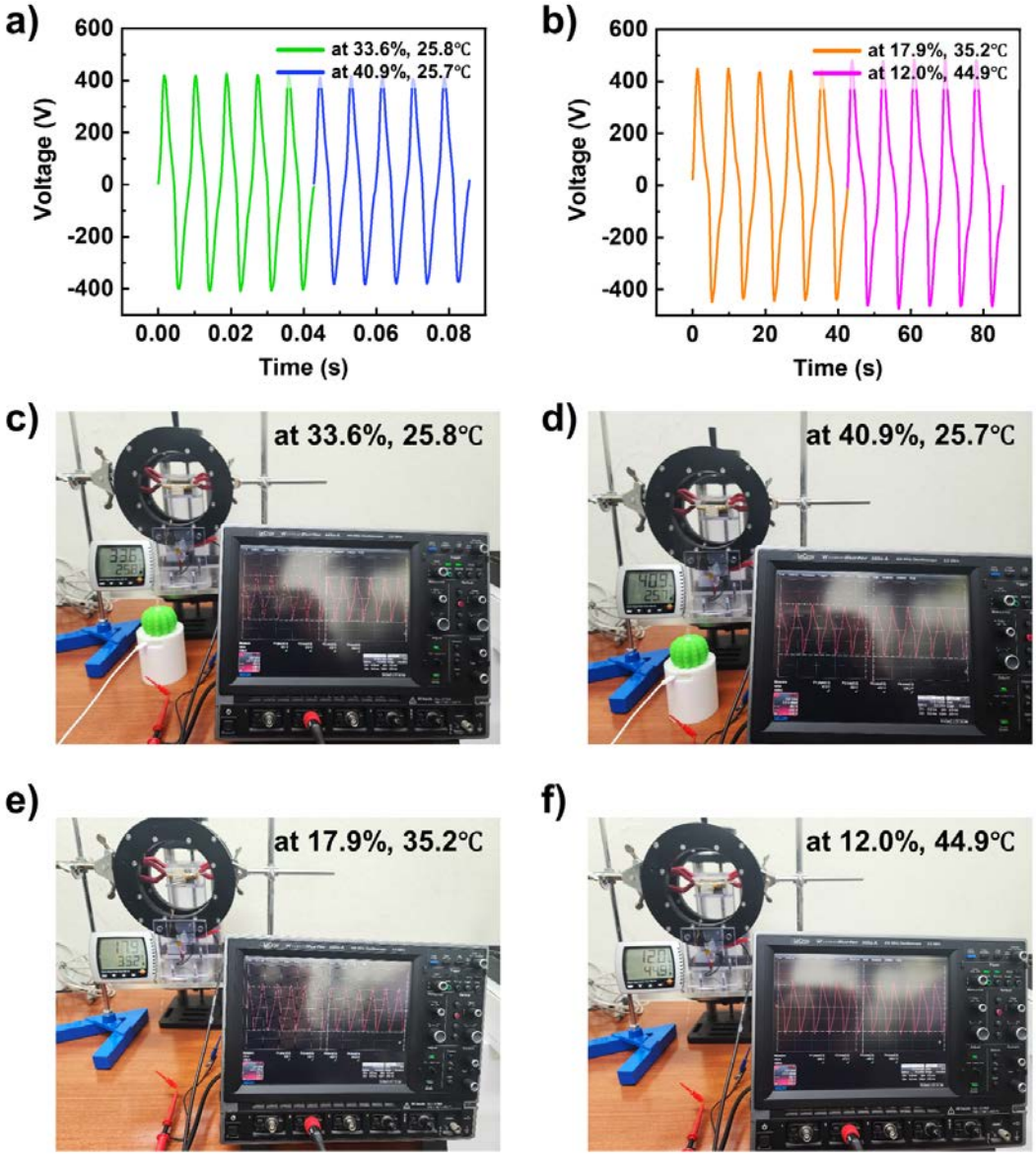

Figure S9. The effect of ambient humidity and temperature for the MMTENG harvesting performance.

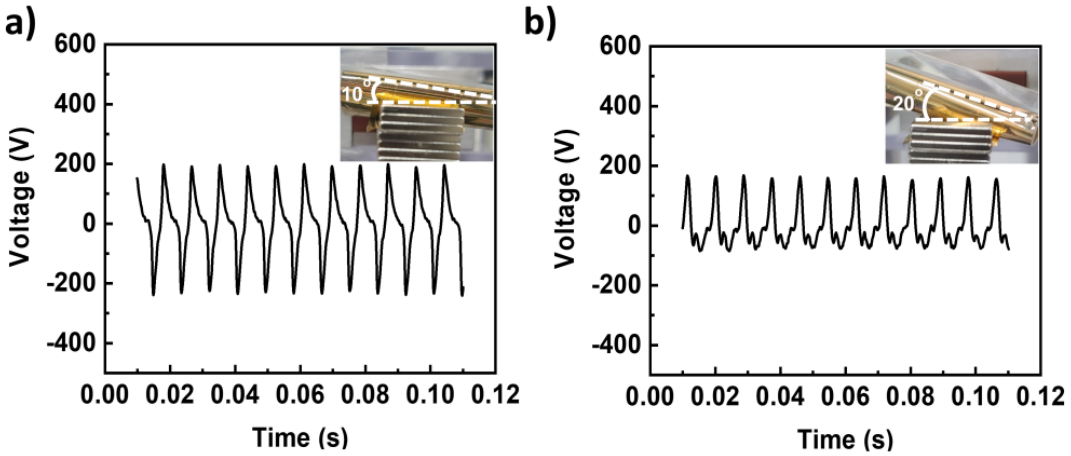

Figure S10. The effect of contact angle between top PFA film and bottom Nylon layer during the MMTENG operation.

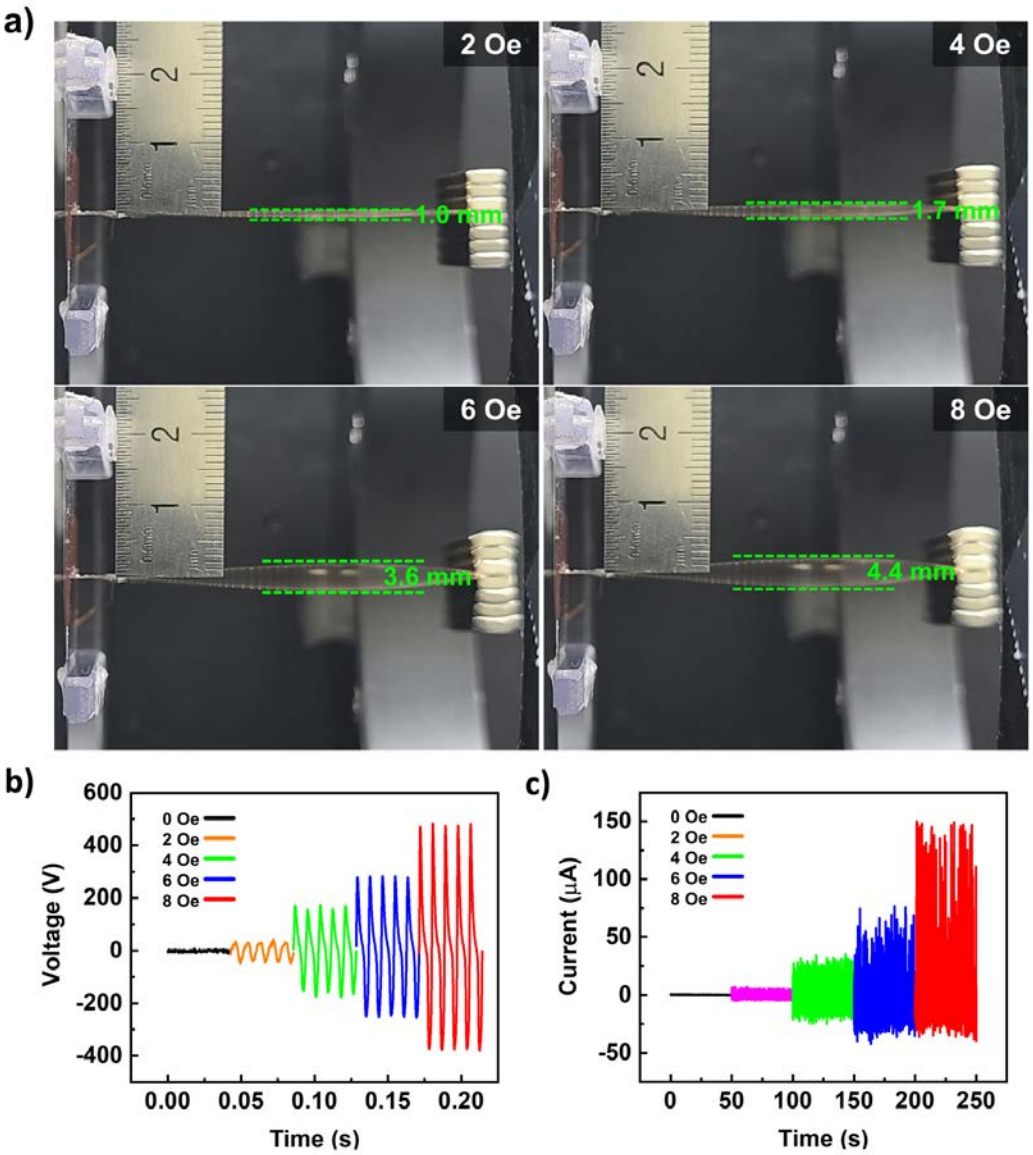

Fig. S11. (a) The up and down vibration displacements of MMTENG cantilever with different AC magnetic fields from 2 Oe to 8 Oe and their corresponding open-circuit output voltage signals (b) and short-circuit current signals (c).

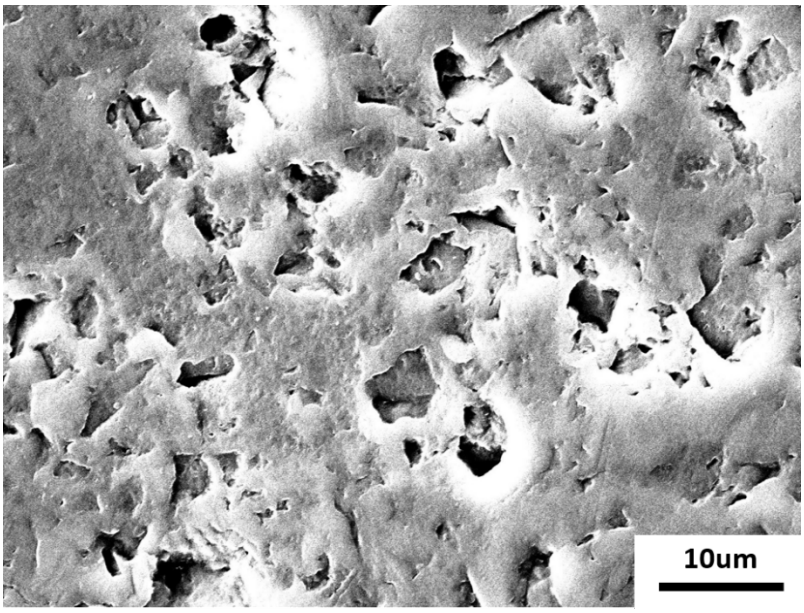

Fig. S12. SEM image of salt imprinted PFA surface after output stability test with 124 million cycles

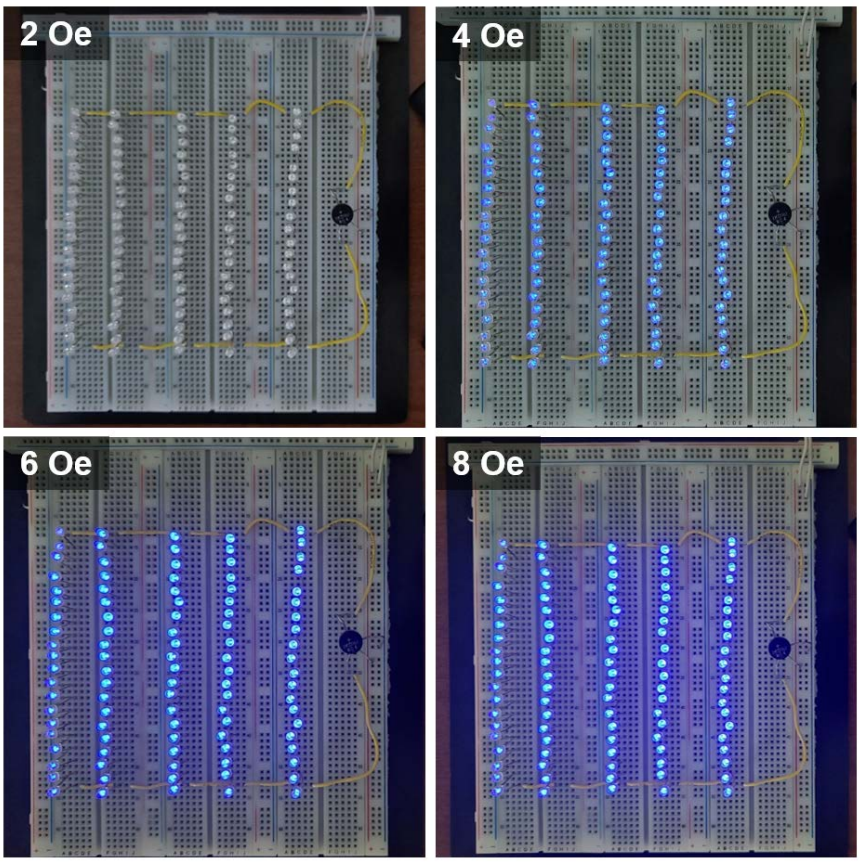

Figure S13. Photo images of hundred blue LEDs as dependence of induced AC magnetic field (from 2 Oe to 8 Oe) on the MMTENG device.