Supporting Information

Triboelectrification-Induced Large Electric Power Generation from a Single Moving Droplet on Graphene/Polytetrafluoroethylene

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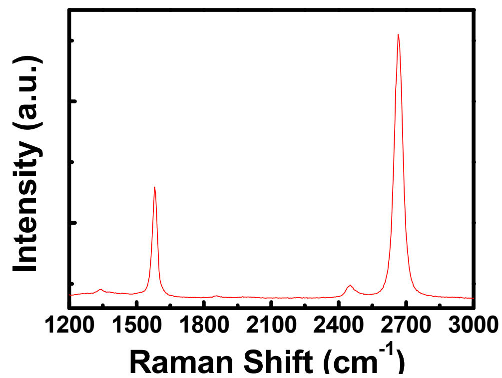

Figure S1. Raman spectroscopy of monolayer graphene.

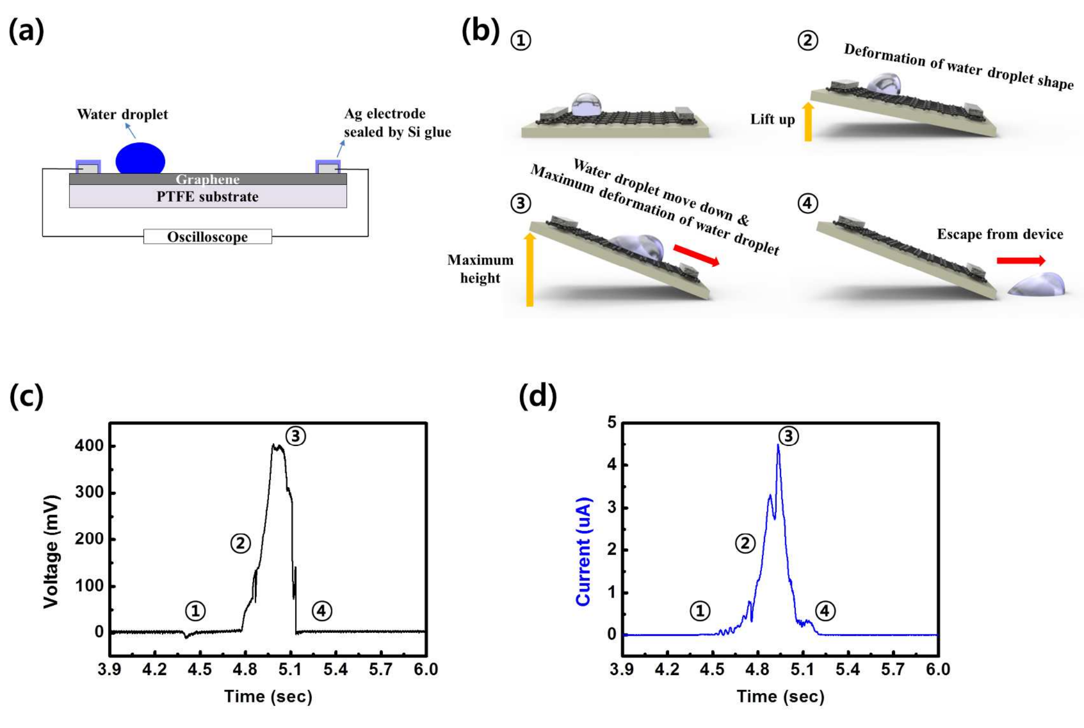

Figure S2. Experimental set-up and electric power output profile. a) Device structure and b) One edge of the graphene/PTFE device is fixed and another edge is lifted up for the water droplet to move down by gravity: 1. Initial state; 2. Starting to lift up one edge of the device and gradually deform shape of water droplet; 3. Maximum deformation of a droplet; 4. Final state. c-d) Output voltage and current profile corresponding to each step shown in (b).

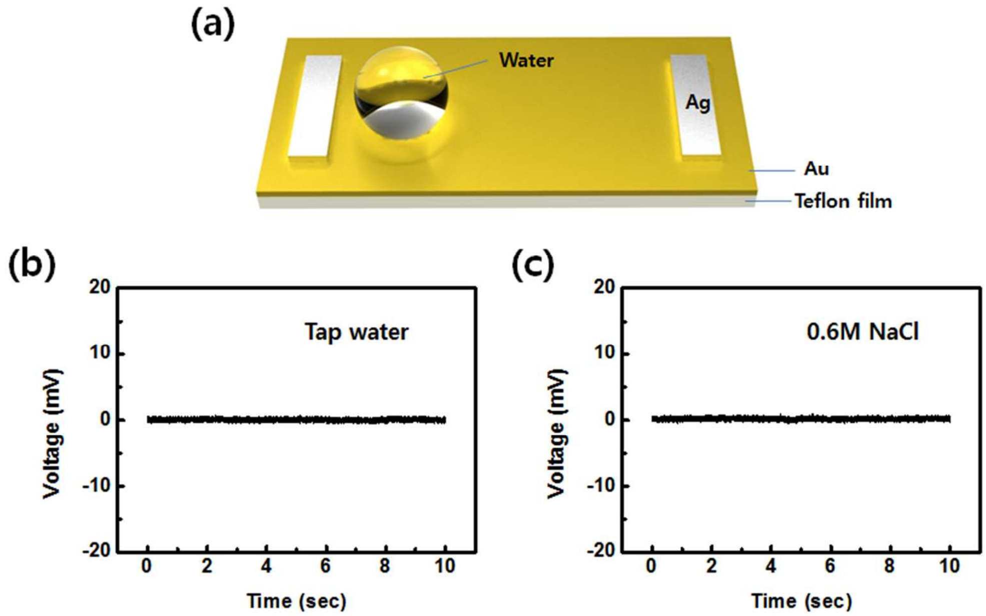

Figure S3. Au thin film/PTFE device. a) Schematic image of Au/PTFE device, b) Voltage output of tap water, c) Voltage output of 0.6 M NaCl. Au thin film with thickness of tens of nanometers deposited on PTFE by a thermal evaporator. Both cases of tap water and 0.6 M NaCl show no voltage output because the effect of the substrate is screened by the high conductivity and thickness of the Au film.

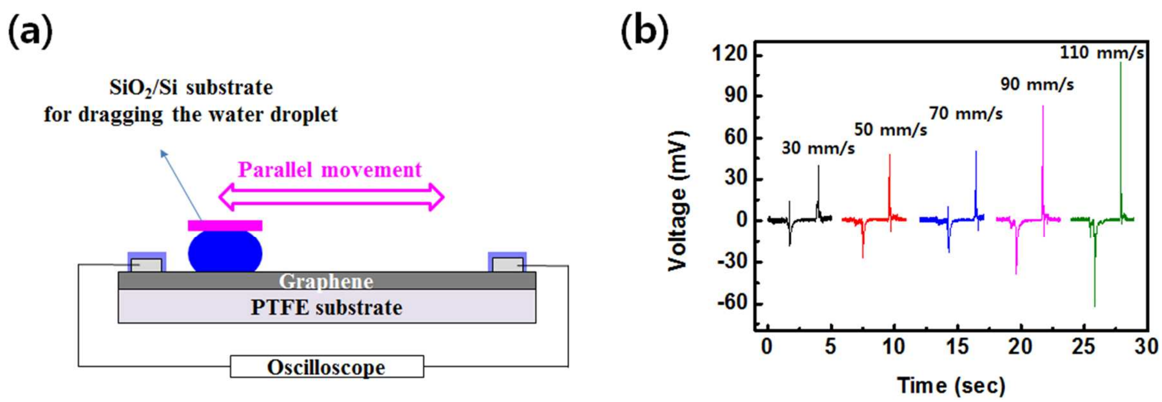

Figure S4. Dependence on moving speed of water droplet. a) Using a linear motor, speed controller and SiO_2/Si substrate, the water droplet on the flat graphene/PTFE structure is dragged at a certain speed with a 0.6 M NaCl droplet of 0.1 ml. b) As the dragging speed increases, the output voltage increases due to the increase in the deformation of the droplet shape.

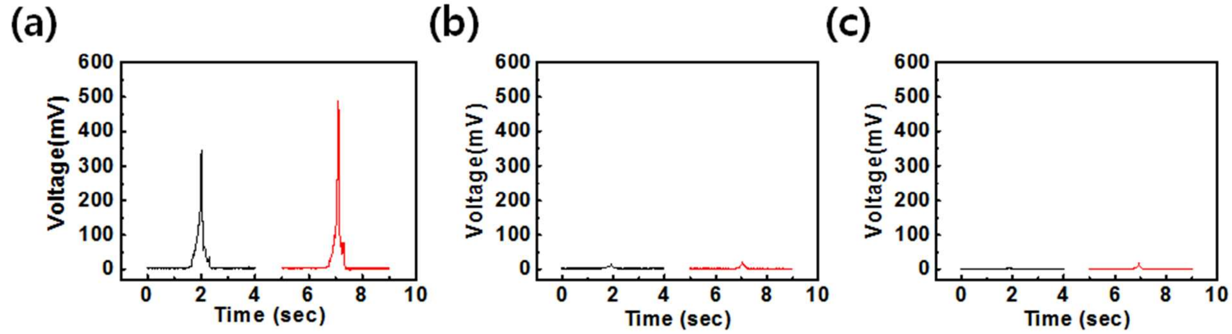

Figure S5. Variation in the voltage output with different substrate materials. The voltage output of a) graphene/PTFE, b) graphene/Kapton, and c) graphene/SiO_2 with tap water (black) and 0.6 M NaCl (red) of the 0.6 ml droplet size.

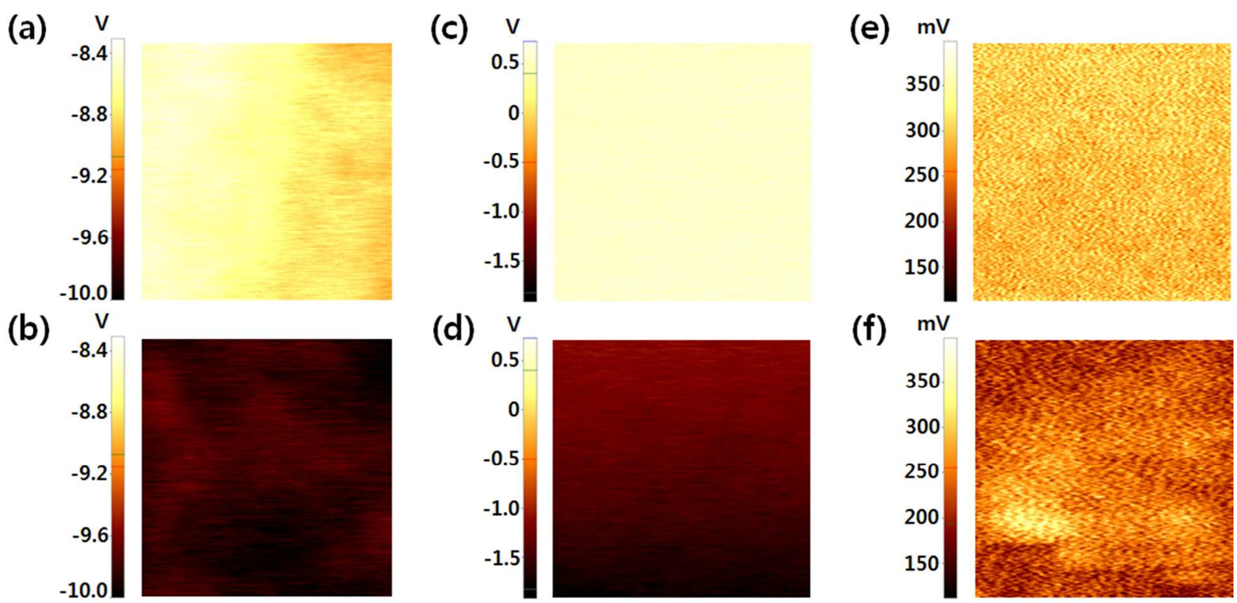

Figure S6. KPFM measurement data of PTFE, Kapton and SiO_2. Surface potential of PTFE film at a) initial state, and b) after immersion into DI water, Kapton film at b) initial state, and c) after immersion into DI water, and SiO_2 substrate at d) initial state and e) after immersion into DI water. Each substrates have lower surface potential after immersion into DI water than that in initial state. These results show that each substrates are more negative charged and DI water is more positive charged by triboelectrification after contact between substrate and DI water.

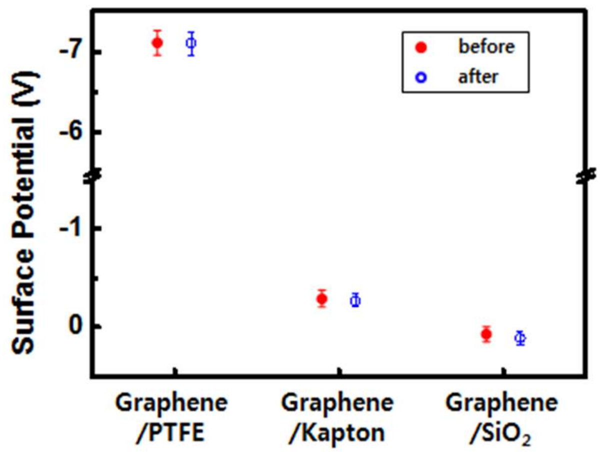

Figure S7. KPFM measurement results of transferred graphene on different substrates. Surface potential of transferred graphene on triboelectrified PTFE, Kapton and SiO_2 substrates at before and after immersion in to 0.6 M NaCl solution.

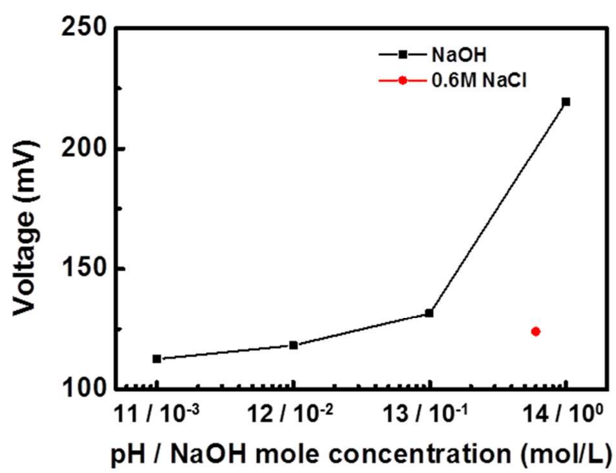

Figure S8. Dependence of the voltage output as a function of pH value of NaOH solution. The output voltage is enhanced by increasing "pH value/NaOH mole concentration". It was found that NaOH solution induces higher output voltage than NaCl solution in same mole concentration and device structure because hydroxide cation has weaker screen effect than chloride cation.[1]

[1] Yin, J.; Li, X.; Yu, J.; Zhang, Z.; Zhou, J.; Guo, W. Generating electricity by moving a droplet of ionic liquid along graphene. Nat. Nanotechnol. 2014, 9, 378-383.

Video S1. Power generation from a single moving droplet by artificially tilting the graphene/PTFE device.

Video S2. Dependence of the voltage output on moving velocity of a single water droplet on graphene/PTFE device and no output signal of a single water droplet on only PTFE without graphene regardless of moving velocity.

Video S3. No significant output signal from single moving droplet by artificially tilting only PTFE device without graphene in reverse electrode connection.