Toward Printed All 2D-based Triboelectric Raindrop Nanogenerators

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Abstract
The triboelectric nanogenerator (TENG) is an emerging technology that can collect raindrop energy to provide all-weather energy harvesting through integration with solar cells [1]. However, the output power of the solar raindrop TENGs is low due to the lack of transparent, and conductive electrodes that meet the appropriate triboelectric series [2,3]. In this research, raindrop TENGs are introduced using graphene as metal contacts and transition metal dichalcogenides (TMDs) nanosheets as the main active layer, respectively. Through liquid phase exfoliation (LPE) and centrifugation, graphene nanosheets of selected size and thickness are obtained, and Langmuir Schaefer-type deposition is used to deposit them on quartz substrates. Transparency and conductivity of films are measured using UV-visible extinction and four-point probes to determine the best compromise between transparency and conductivity for TENG contacts. The addition of carbon nanotubes is also considered to increase conductivity at reduced transparency.
To provide the active area of the TENG, TMDs with selected sizes and thicknesses are sandwiched between both graphene electrodes. The open-circuit voltage and short-circuit current of the devices are measured for different thicknesses of active materials, as water droplets are dropped onto the active area. The impact of each water droplet can be clearly seen as peaks in the response. The newly developed all-2D based TENG devices based on solution-processed 2D materials provide exciting perspective since they allow rapid screening of the active layer and potential for chemical surface modification to tune the hydrophobicity of the surface.

References

[1] Ye, Cuiying, et al. Advanced Materials 35.11 (2023): 2209713.
[2] Zheng, Yang, et al. Advanced Materials 34.28 (2022): 2202238.
[3] Xie, Lingjie, et al. ACS nano 16.4 (2022): 5292-5302.

Figures

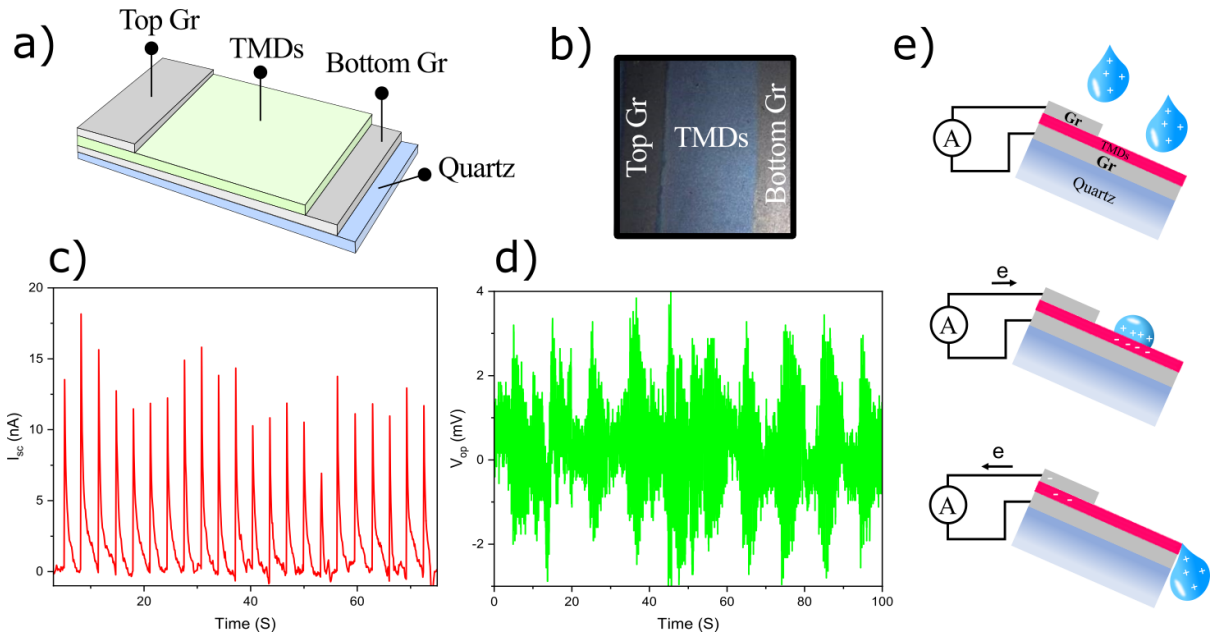

Figure 1: a) schematic illustration and, b) optical photograph of the device. c) short circuit current, d) open circuit voltage characterizations, and e) mechanism of power generation.