Liquid single-electrode triboelectric nanogenerator based on graphene oxide dispersion for wearable electronics

Yinghong Wu [1, 2], Jingkui Qu [1], Walid A. Daoud [2], Tao Qi [1]

[1] *Institute of Process Engineering, Chinese Academy of Sciences, Beijing 100190, China.*
Tel: 852-66769115; E-Mail: wuyinghong@ipe.ac.cn

[2] *School of Energy and Environment, City University of Hong Kong, Kowloon, Hong Kong*

1. Introduction –With the rapid growth of wearable electronics, flexible and high-performance power sources has attracted increasing attention [1]. Among various energy harvester, triboelectric nanogenerator (TENG) is highly promising owing to its light weight, easy fabrication, broad material selection, various working modes, and high conversion efficiency [2]. However, many traditional TENG are based on relatively hard materials, which decreases the effective contact between the triboelectric pair and further the output performance. Although more and more flexible TENG have recently been developed, they still show confined deformability and are hardly used in highly flexible and shapeadaptable devices.

2. Results and Discussion –By employing graphene oxide (GO) dispersion as the liquid electrode while PDMS as the electrification layer, novel liquid single-electrode TENG (LS-TENG) with simple structure and high flexibility and deformability, is developed for the first time. The output performance is remarkably improved by adding a small amount of GO dispersion (10 mg·mL^{-1}, 0.35 mL), owing to the 2D structure and the large surface area of GO facilitating the electrons transfer in the liquid. For example, its open-circuit voltage (V_{OC}) and short-circuit current density (J_{SC}) are 123.1 V and 18.61 mA·m^{-2}, respectively. This is much better than the reported LS-TENG based on NaCl solution and liquid metal. Moreover, the maximum power density of this device achieves 4.95 W·m^{-2} (1.98 mW) at a contact frequency of 3 Hz, which is even higher than that of reported GO solid single-electrode TENG (3.13 W·m^{-2}, 5 Hz) [3]. When palm taps the device with an electrode size of 2×2 cm^2, 87 green LEDs in series can be lit up. Tests, such as robustness in 2200 cycles, durability after 25 days storage, and repeatability for five devices, all indicate its high stability and potential in practical application. Minute body movement inputs on skin and clothes, indicate its high sensitivity and potential use in highly-flexible and highly-deformable wearable electronics.

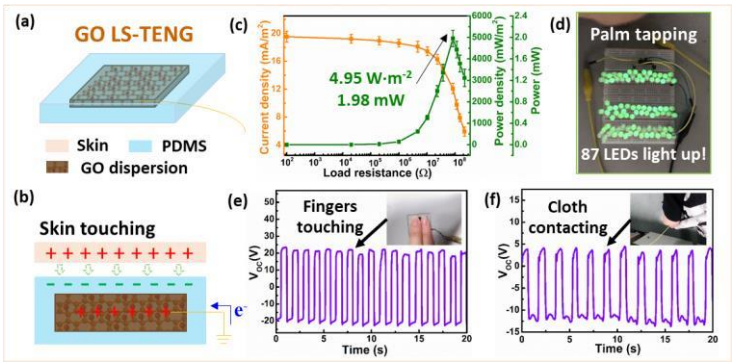

Image 1. (a) Schematic diagram of the GO SL-TNEG, (b) Working principle, (c) Average power density at various load resistance, (d) photograph of lighting up 87 green LEGs, (e,f) output voltage by fingers touching and cloth contacting.

3. Conclusions - This work demonstrates a novel approach to fabricate LS-TENG with easy fabrication, high performance, and high sensitivity for use in highly flexible and deformable wearable devices.

4. References

[1] Z. Wen, M.H. Yeh, et al, Sci. Adv. 2 (2016) e1600097. [2] J. Ma, T. Zhou, et al, Nano Energy 44 (2018) 199-207. [3] H. Guo, T. Li, et al, ACS Nano 11 (2017) 856–864.