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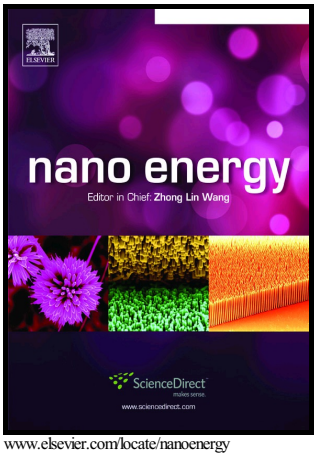

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Abstract

With the successive advent of piezoelectric nanogenerator (PENG) and triboelectric nanogenerator (TENG), the harvest of ambient mechanical energy has become more high-efficient, low-lost and simpler for self-powered systems. Introducing lightweight alternative power source to bionic micro aerial vehicle (BMAV) which is widely used for military surveillance or monitoring air pollution and so on, is the forefront of the research hotspots. However, there is still no design applying the two kinds of nanogenerator (NG) together in BMAV to collect the flapping mechanical energy more efficiently. In this paper, we demonstrate a hybrid flexible nanogenerator (HFNG) based on the combination of triboelectric and piezoelectric devices in BMAV. It not only can solve the problem of power supply, but also make the BMAV intelligent to monitor the changes of specific environmental factors. The newly designed HFNG can produce a maximum open-circuit voltage of 80 V, short-circuit current of 3.0 μA with the instantaneous output power density of 34.1 mW/m^2 when the flapping frequency of BMAV (*f*) is 14 Hz. The rectified output of HFNG has been applied to charge the commercial capacitor, rechargeable battery and drive light-emitting diodes. It was also demonstrated that HFNG can be used for testing the lift force (*L*) of BMAV. Moreover, the output performances of HFNG have been proved to be sensitive to temperature, humidity, alcohol concentration and PM2.5 in the environment.

Graphical abstract:

[1] Guowu Wei and Yaqi Bi contributed equally to this work