A triboelectric-electromagnetic hybrid generator for wave energy harvesting

Yawei Wang[a] (Master Degree Candidate)
Yan Wang[a] (PhD Candidate)
Hao Wang[a] (Assistant Professor)
Minyi Xu[a] (Professor)
[a] *Dalian Maritime University, Dalian, 116026, China*

Abstract

Wave energy is one of the most promising renewable energy sources in the ocean, which comes with high energy density, water depth independence and 24-hour availability, collecting low-frequency wave energy by triboelectric nanogenerators (TENGs) is still a considerable challenge. In this study, a hybrid wave energy harvester (H-WEH) is proposed. Herein, the H-WEH composes coupled TENG and electromagnetic generator (EMG). This design exhibits better output performance in harvesting wave energy compared with individual components. Moreover, the electricity generation unit makes no direct contact with the water surface, which enhances the durability of the generator. Additionally, the output characteristics of TENG can be complementary to the performance of EMG to achieve satisfactory power production. The device can work in the frequency range of 0.1-1Hz, which provides a simple, reliable, and durable alternative for large-scale and low-frequency wave energy harvesting.

Figures

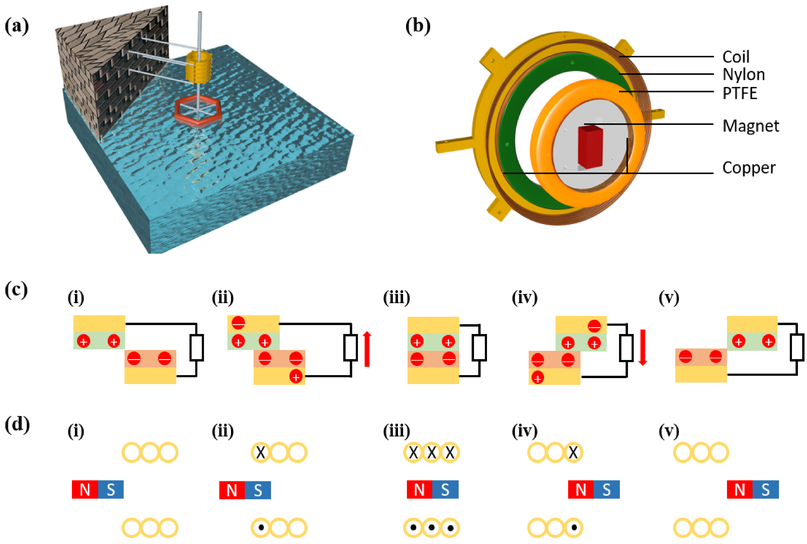

Figure 1. Structural design and working principles of the T-TENG. (a) Schematic diagram of the designed H-WEH consisting of multiple units. (b) Exploded view of the H-WEH's structure. (c) The working principle of the TENG component. (d) The working principle of the EMG component.

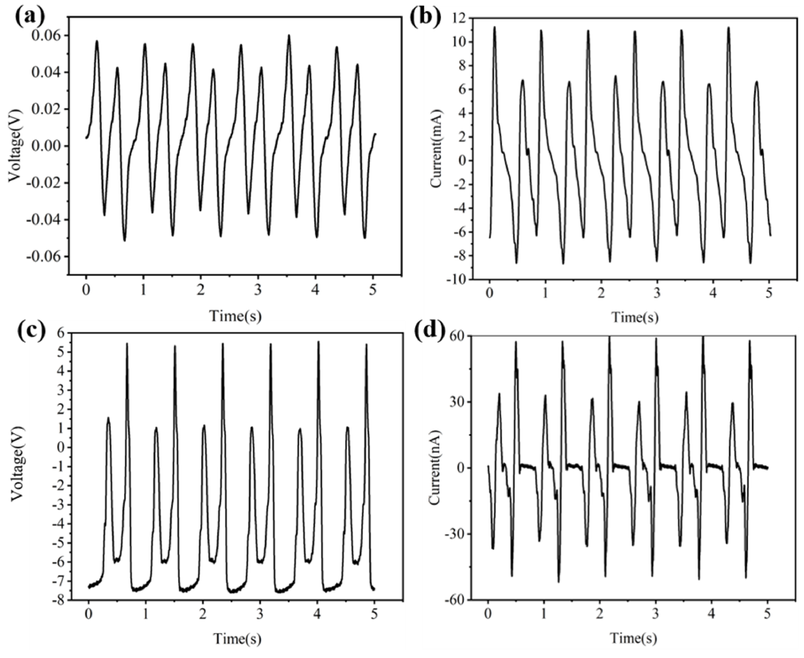

Figure 2. The output characteristics of H-WEH under the excitation of waves with a frequency of 1HZ and a height of 5CM. (a) TENG's voltage curve. (b) TENG's current curve. (c) EMG's voltage curve. (d) EMG's current curve.

Conclusion

In summary, we have designed a hybrid generator by combining TENG and EMG together to harvest wave energy. Benefiting from the design of the float and the power generation unit, the H-WEH can be used for low-frequency wave energy collection. The power generation performance of H-WEH under different frequencies has been studied systematically. Under the excitation of 1Hz frequency and 5cm wave height, the TENG component can output a voltage of 20V and a current of 0.5μA, while the EMG component can output a voltage of 0.08V and a current of 10mA. For the demonstration, a capacitor was charged successfully through the H-WEH in the water tank, which is superior in maximum charging value and speed compared with individual EMG and TENG components. Because of its small size and easy materials availability, the H-WEH could become a novel way to capture ocean energy.