Development and Application of Plain Weave Structured Triboelectric Nanogenerators for Energy Harvesting and Sensing

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Abstract: Wearable technology is advancing at a rapid pace, necessitating the exploration of sustainable power sources such as triboelectric nanogenerators (TENGs). However, the challenge lies in creating wearable TENGs that are flexible, breathable, and washable. In this study, we introduce a novel plain weave structured triboelectric nanogenerator (PW-TENG) designed using a simple, cost-effective, and scalable weaving technique. The PW-TENG is constructed using commercially available silver-plated nylon yarn (SNY) and cotton yarn, which serve as triboelectric positive materials. The corresponding layer is composed of a highly elastic polymer, polydimethylsiloxane (PDMS), doped with $BaTiO_3$, acting as a triboelectric negative material. The unique self-resilient structure of the PW-TENG allows it to achieve an open-circuit voltage, short-circuit current and power density of 280 V, 9.85 μA and 1690.44 mW/m^2. Furthermore, for the potential applications of the PW-TENG, we have integrated it into insoles, t-shirts, and trousers to harness various forms of mechanical energy generated by human movement. The impressive output power performance of the PW-TENG, combined with human motion and textiles, suggests promising applications in smart textiles in the foreseeable future.

Keywords: *Triboelectric Nanogenerator, Weaving Structure, Energy harvesting, Smart Textiles, Human Motion.*

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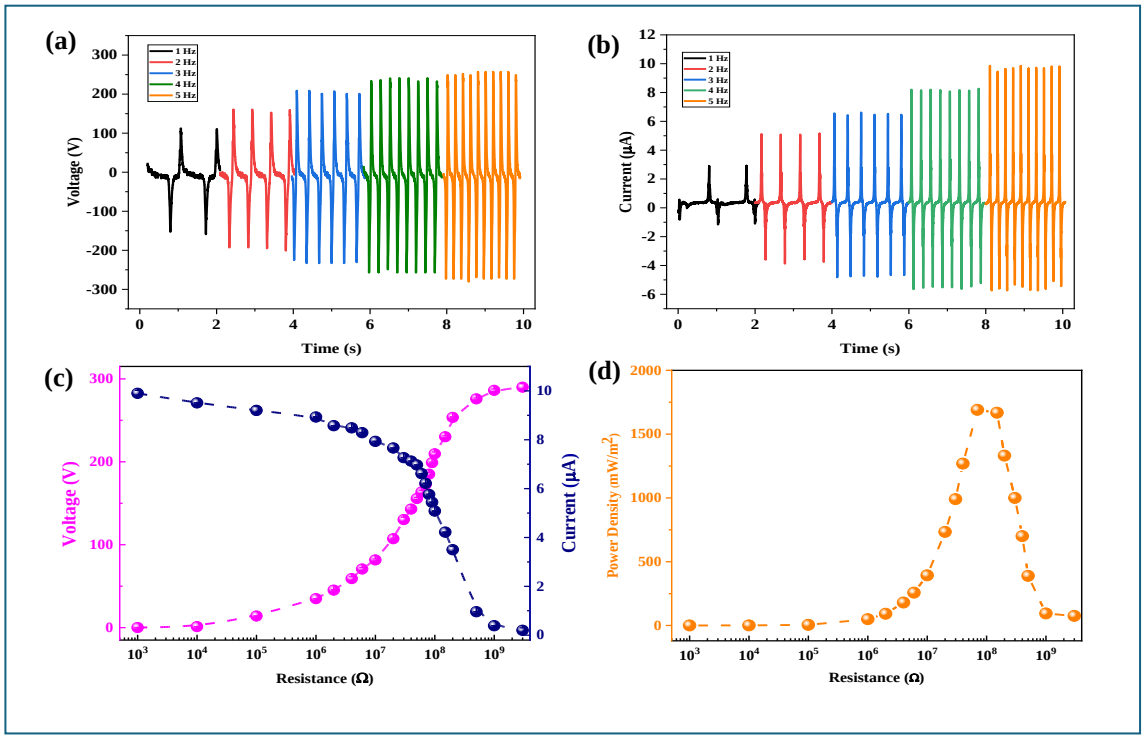

Figure 1: (a) Output voltage and (b) Short-circuit current (c) Output voltage and current of the PW-TENG on load resistances. (d) Power density of the PW-TENG on load resistances.