Mechanics of Sliding Triboelectric Nanogenerators for Sustainable Energy Harvesting

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Abstract

The triboelectric nanogenerator (TENG) is a new and rapidly advancing energy generation technology that has attracted considerable research interest over the past decade [1,2]. When operated in free-standing mode, TENGs are effective at generating energy in a sustainable manner from low-frequency mechanical motions. TENG offers several advantages over its counterpart generators, most notably their low cost, light weight, easy processing and resistance to corrosion [3,4]. However, conventional TENG devices require precise alignment between functional layers, which is difficult to achieve in a dynamic sliding situation and requires complex arrays of roller bearings, adding frictional losses to the system.

In this work, a novel sliding form-factor triboelectric nanogenerator (S-TENG) is proposed which employs compliant parts as a compact, low-cost mechanism to improve alignment between tribo-layers, leading to improved energy harvesting efficiency. The newly designed S-TENG consists of a compliant stator cylinder containing two sets of electrodes, and a mover cylinder with a ring of dielectric material constrained on its outer surface. Relative axial motion between the stator and mover generates a potential difference between the two electrodes via contact electrification and electrostatic induction. The original design utilises a compliant gripping mechanism which ensures conformal contact as TENG output has been found to be very sensitive to real contact area. The S-TENG shows promising electrical output which varies directly with sliding speed and radial force, indicating great potential for use in a variety of energy harvesting applications, including self-powered sensors, and wireless communication devices. Future work will focus on optimizing the mechanical design parameters of the S-TENG and investigating its performance (power output, stability, and durability) under different operating conditions to further enhance its energy harvesting capabilities.

References

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