Investigating Triboelectrification Through Real Contact Area Analysis

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Abstract

In recent years, the usage of sensors and self-powered devices has significantly increased, resulting in a high demand for sustainable, portable, and distributed power sources. The triboelectric nanogenerator (TENG) is a newly developed and rapidly growing energy generation technology that converts mechanical energy into electrical energy [1]. The working mechanism of TENG is based on the coupling of contact electrification and electrostatic induction effects during repeated contact-separation cycles [2,3]. Over the past decade, research on TENGs has significantly expanded globally. However, the fundamental governing mechanisms are not very clear yet [1]. In this work, a single-electrode triboelectric nanogenerator was developed, including an elastomeric rough surface and a metal-contacted electrode. Elastomeric surfaces were fabricated using the replica micro-moulding technique [4]. A 3D optical surface profiler was used for the morphological characterization of the developed tribo-layers. Characterization results confirmed the uniform roughness and global flatness of tribo-layers. An electro-mechanical test setup (based on the contact-separation mode of TENG) was developed to simultaneously record contact forces, in-situ real contact area and electrical potential. The original test setup utilises a contact alignment mechanism which ensures perfect flat-flat contact alignment between contact tribo-layers as TENG output has been found to be very sensitive to the contact area [5]. The comprehensive electro-mechanical investigation results provide an improved understanding of triboelectrification in TENGs at a local scale and emphasise the underlying role of real contact junctions. Future work will focus on utilizing a range of hard and soft materials under different operating conditions.

References

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