Origami-Tessellation-Based Triboelectric Nanogenerator For Energy Harvesting With Application In Road Pavement

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The output performance of the current origami inspired Triboelectric Nanogenerator (TENGs) are limited by the simple origami pattern used as the TENGs base. In the previous references, most of the origami based TENGs tried to use the multilayer origami to increase the surface areas. However, the electric output is limited by the simple configuration of the involved origami pattern. To address the problems mentioned above and expand the application area of TENG, in this paper, we propose a new kind of origami-tessellation based TENG (OT-TENG) with following advantages. First, the OT base is folded from a single piece of paper to form a periodic structure with many contact faces to install tribo-pairs. The multilayer configuration of the origami increases the surface areas and thus enhances the electrical output. Second, the OT base can be flat-foldable, which indicates that the thickness of the device is the thickness of the stack of papers when the OT bases are fully folded. Third, the proposed OT bases could be driven by very small stimulation, because the energy stored in the mountain and valley folds between two facets may provide the structure resilience to its original configuration. Fourth, different from most of TENGs that can only suitable for energy harvesting from pressure or tension-induces incentives, the OT-TENGs can be driven by either traction or compression depending on the initial configuration of the OT base, which broadens the usage of the proposed devices. The OT base provides multi layers facets to install tribo-pairs and can be driven by very small stimulation owing to the resilience of the structure. It can be operated effectively under either traction or compression depending on the initial configuration of the OT base. Besides, the foldability of the OT base makes easily the developed devices to be fitted thin gap in the road pavement. A series of mechanical tests are carried out to study the output performance of a quadrangular prism shape OT-TENG based on the Arc pattern under different boundary conditions and frequencies. To guarantee the motion synchronicity of the OT base, a strip-shape OT-TENG based on the Miura pattern is designed to obviously increase the output performance as the number of the tribo-pairs increases. Then, the tracking board test shows the potential application of the OT-TENGs for pavement vibration energy harvesting. By constructing a two-dimensional network of the OT-TENGs in pavement, the devices will provide a feasible green energy to meet the energy need of the intelligent transportation systems in the future. The outcomes of this work offer a novel OT-TENG design with great potential to dramatically enhance the output performance of TENGs devices in more general shape space and more flexible environment for vibration energy harvesting.