New smart textile can simultaneously harvest energy from sun and motion

With the support by the National Natural Science Foundation of China and the Ministry of Education of China, a joint research team led by Prof. Wang ZhongLin at the Georgia Institute of Technology in Atlanta and Beijing Institute of Nanoenergy and Nanosystems in China, Assoc. Prof. Fan Xing (**范兴**) at Chongqing University in China, invented a new type of smart textile, which could simultaneously harvest solar and mechanical energy to power electronic devices. This work was published in *Nature Energy* (2016, 1: 16138).

Developing lightweight, flexible, foldable and sustainable power sources with simple transport and storage remains a challenge and an urgent need for the advancement of next-generation wearable electronics. Combining two types of electricity generation into one textile would pave the way for developing garments that could continuously provide energy to power devices such as smartphones, smart watches or global positioning systems.

Regarding the smart hybrid textile, solar cells fabricated from lightweight polymer fibers into micro cables are then woven with fiber-based triboelectric nanogenerators, into a single-layer textile of 320 μm thick. In the textile, the fiber solar cells were made by assembling dye-sensitized zinc oxide nanowires on manganese and copper-coated plastic wires. The other power-generating component was the triboelectric nanogenerators, which was composed of thin and slender strips of copper coated with a Teflon-like polymer. A textile, with a size of 4 cm by 5 cm, was capable of outputting a voltage of 5 V under ambient sunlight in the presence of mechanical excitation, such as human motion and wind blowing, which was demonstrated to power a wristwatch, to charge a cell phone and to drive water splitting reactions.

Before they obtained the breakthrough on the smart hybrid textile, Fan Xing had begun the research on fiber solar cells ever since his PhD study at Peking University, and successfully fabricated the all-solid photovoltaic textile and the solar energy harvesting-storage hybrid textile after he went to work at Chongqing University in 2009. The project of the hybrid textile had started in 2014, when Fan was a one-year visiting scholar in Prof. Wang's group at Georgia Tech. Prof. Wang ZhongLin was the inventor of the triboelectric nanogenerators (TENG), which could use a combination of the triboelectric effect and electrostatic induction to generate electrical power from mechanical motion such as rotation, sliding or vibration. In the next two years, they designed and fabricated the single-layer TENG textile, and then overcame such obstacles as the mixed knitting process and the electrical matching of the two different energy-harvesting components, even after Fan went back to Chongqing University in 2015. Finally, well-working hybrid energy textiles with various patterns were fabricated via a shuttle-flying process, which could be escalated to mass production of larger energy-generating structures, like curtains or tents. Furthermore, by tweaking the patterns and configurations, the electrical output of the textile could be customized for specific applications, including both high-light and low-light environments.

More interestingly, the concept of utilizing traditional textile techniques to fabricate functional devices could also be applied in addition to energy harvesting devices. The fabrication process allows the combination with other fiber-based functional devices, like sensors, to form an intelligent integrated system. It is expected that, in the near future, everything can be a textile and that every electronic device will eventually become a part of a textile system—from fiber-based airplane structures and space station inflatable modules to wearable power generators, like the one described in the *Nature Energy* paper.

Figure A bracelet made from the smart textile that powers a wrist watch.