Stretchable multi-functional fiber for energy harvesting and strain sensing

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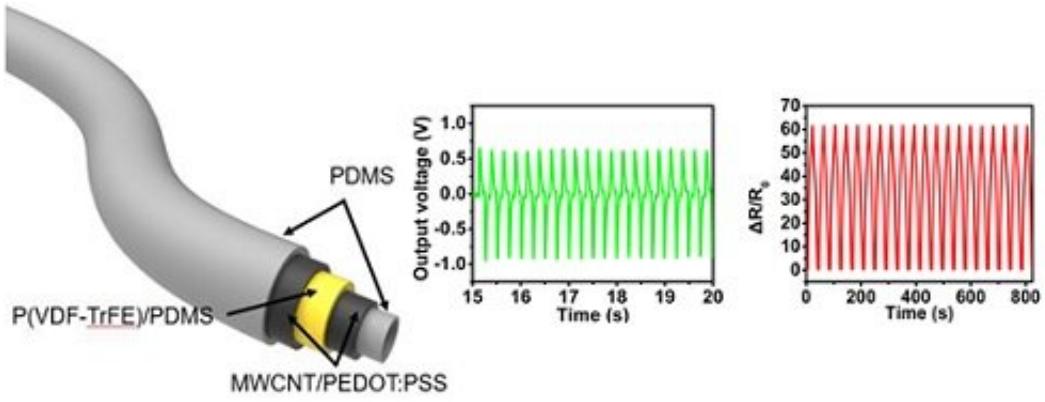

Figure 1.Schematic illustration of an SMF fiber and its piezoelectric voltage output and response to strain. Credit: The Korea Advanced Institute of Science and Technology (KAIST)

Fiber-based electronics are expected to play a vital role in next-generation wearable electronics. Woven into textiles, they can provide higher durability, comfort, and integrated multi-functionality. A KAIST team has developed a stretchable multi-functional fiber (SMF) that can harvest energy and detect strain, which can be applied to future wearable electronics.

With wearable electronics, health and physical conditions can be assessed by analyzing biological signals from the human body, such as pulse and muscle movements. Fibers are highly suitable for future

wearable electronics because they can be easily integrated into textiles, which are designed to be conformable to curvilinear surfaces and comfortable to wear. Moreover, their weave structures offer support that makes them resistant to fatigue. Many research groups have developed fiber-based strain sensors to sense external biological signals. However, their sensitivities were relatively low.

The applicability of wearable devices is currently limited by their power source, as the size, weight, and lifetime of the battery lessens their versatility. Harvesting mechanical energy from the human body is a promising solution to overcome such limitations by utilizing various types of motions like bending, stretching, and pressing. However, previously reported, fiber-based energy harvesters were not stretchable and could not fully harvest the available mechanical energy.

Professor Seungbum Hong and Professor Steve Park from the Department of Materials Science and Engineering and their team fabricated a stretchable fiber by using a ferroelectric layer composed of P(VDF-TrFE)/PDMS sandwiched between stretchable electrodes composed of a composite of multi-walled carbon nanotubes (MWCNT) and poly 3,4-ethylenedioxythiophene polystyrenesulfonate (PEDOT:PSS).

Figure 2. Photographs of a stretchable multi-functional fiber being stretched by 100%, bent, and twisted. Credit: The Korea Advanced Institute of Science and Technology (KAIST)

Cracks formed in MWCNT/PEDOT:PSS layer help the fiber show high sensitivity compared to the previously reported fiber strain sensors. Furthermore, the new fiber can harvest mechanical energy under various mechanical stimuli such as stretching, tapping, and injecting water into the fiber using the piezoelectric effect of the P(VDF-TrFE)/PDMS layer.

Professor Hong said, "This new fiber has various functionalities and makes the device simple and compact. It is a core technology for developing wearable devices with energy harvesting and strain sensing capabilities."

More information: Jeongjae Ryu et al. Intrinsically stretchable multi-functional fiber with energy harvesting and strain sensing capability, *Nano Energy* (2018). DOI: 10.1016/j.nanoen.2018.10.071

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