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Fiber Electronics

Huisheng Peng

Fiber materials, including natural fibers discovered thousands of years ago and man-made fibers invented over a century ago, are indispensable for the basic life of humankind, as, for instance, they have been woven into textiles to keep us warm since the ancient times. The resulting textiles have also gradually become a key part of fashion, particularly in the past centuries. In the most recent decades, fiber materials have experienced a revolution into a new epoch of electronic devices with various functions based on the rapid advance of information technology and artificial intelligence. Fiber-shaped electronic devices may harvest energy, store energy, light, and detect environmental changes both in vitro and in vivo, and many new fiber-shaped electronic devices such as transistors are also emerging.

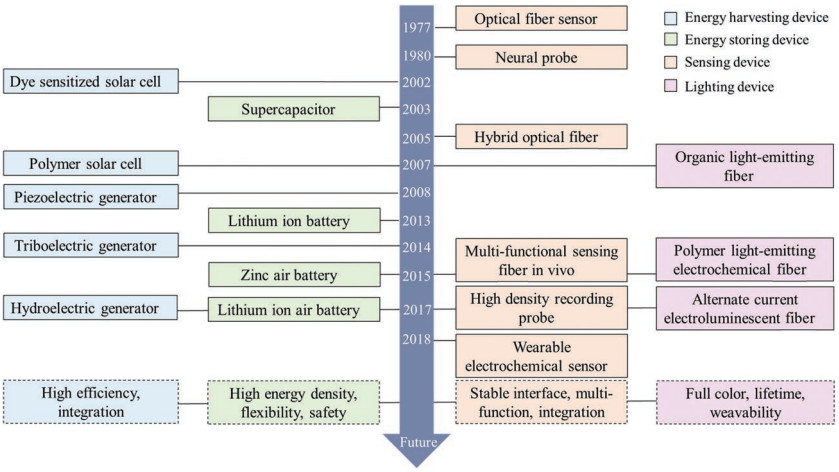

Figure 1. A timeline showing the advance of fiber-shaped electronic devices with regard to the four main functions: energy harvesting, energy storage, sensing, and lighting.

Compared with traditional bulky and film-like devices, ultra-flexible fiber-shaped electronic devices may closely and stably adhere to irregular substrates and accommodate complex deformations such as twisting and stretching. They have been thus extensively explored for a variety of promising fields such as soft robotics, biomedical engineering, and smart life. They can be also woven into electronic textiles that breathe freely or that are integrated into/onto the human body, particularly for use in wearable and implantable materials, which was previously unavailable for their traditional counterparts. The boom of electronic fiber materials and devices gives birth to a new research field or even discipline, i.e., fiber electronics, which I may name here.

Functional materials play a critical role in the advance of fiber electronics. To further push fiber electronics ahead, it is necessary and important to highlight the main achievements in this new area from the viewpoint of materials science, and therefore we have organized this special issue of *Advanced Materials*. For the collected sixteen articles, including 10 *Reviews* and 6 *Progress Reports*, the main efforts are made in summarizing various fiber electronic materials, devices, and applications by taking advantage of the distinctive interface internally and externally from the one-dimensional configuration, and the remaining challenges and future directions are carefully explored too.

Prof. H. S. Peng
State Key Laboratory of Molecular Engineering of Polymers
Department of Macromolecular Science, and Laboratory of Advanced Materials
Fudan University
Shanghai 200438, China
E-mail: penghs@fudan.edu.cn

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As basic building blocks, fiber electrodes play a critical role in determining the performance of fiber-shaped electronic devices, so they have been explored intensively in the past decade. Fiber electrodes are discussed according to their composition (e.g., metal, carbon, polymer, and composite) and have been particularly compared for their mechanical, electrical, and electrochemical properties, which are highly important for the resulting fiber-shaped electronic devices. In this special issue, two promising candidates are considered: carbon nanotube and graphene, for fiber electrodes, with contributions to this discussion from Qingwen Li and co-workers (article number 1902028), Chao Gao and co-workers (article number 1902664), and Liangti Qu and co-workers (article number 1901979).

The main kinds of fiber-shaped electronic devices that function for energy harvesting (e.g., solar cells, triboelectric and piezoelectric generators, fluidic generators, and water generators (reviewed by Zhong Lin Wang and co-workers in article number 1902549 and Jun Zhou and co-workers in article number 1902034)), energy storage (e.g., supercapacitors, metal-ion batteries, metal–air batteries, and lithium–sulfur batteries (reviewed by Chunyi Zhi and co-workers in article number 1902151, Xinbo Zhang and co-workers in article number 1901961, Yuan Chen and co-workers in article number 1902387, Liming Dai and co-workers in article number 1902779, and Guozhen Shen in article number 1901806)), lighting (e.g., organic light-emitting diodes, polymer light-emitting electrochemical cells, and inorganic electroluminescent devices (discussed by Kyung Cheol Choi and co-workers in article number 1903488)), and sensing (e.g., chromatic devices, actuators, and electronic and electrochemical sensors (reviewed by Seon Jeong Kim and co-workers in article number 1902670)) are compared

with regard to the conventional three-dimensional and two-dimensional counterparts. **Figure 1** summarizes the key steps in the advance of the four main kinds of fiber-shaped electronic devices.

This special issue centers more on the differences in properties that originate from the different interfaces and structures (e.g., coaxial, twisting, and interlaced). Charge generation/separation, collection, and transport processes at the curved interfaces of fiber-shaped electronic devices are also reviewed. The integration of the above different functions is highlighted as a unique advantage during use. In particular, the main efforts made to describe the key advances on stretchable properties in one dimension (summarized by Taeyoon Lee and co-workers in article number 1902532) and promising integration methods (summarized by Meifang Zhu and co-workers in article number 1902301) are considered.

The remaining challenges of fiber-shaped electronic devices are also outlined. Scientifically, further investigation of the distinctive interface is necessary to guide performance enhancement. Technically, emphasis is made with regard to the general and effective strategies for the large-scale production of fiber electrodes and reliable connection of fiber-shaped electronic devices. Attention is also paid toward summarizing the representative strategies to enhance their properties. For practical applications, the stability of fiber-shaped electronic devices under different deformations is studied from the viewpoint of adaptable interfaces with soft tissues. The promising applications in interdisciplinary fields including microelectronics and biomedical engineering are highlighted by Xiaoming Tao and co-workers in article number 1901958 and by Huisheng Peng and co-workers in article number 1901971.

Huisheng Peng is Changjiang Chair Professor at the Department of Macromolecular Science and Laboratory of Advanced Materials at Fudan University. He and his co-workers have explored a new family of fiber-shaped energy-harvesting devices including perovskite solar cells and fluidic generators, fiber-shaped energy-storage devices including lithium-ion batteries, lithium–sulfur batteries, and metal–air batteries, fiber-shaped light-emitting devices, and fiber-shaped sensors; thus a new direction of fiber electronics is started. He is now interested in the application of fiber electronics to solve biomedical problems.

To close, I greatly appreciate for the kind support from the editorial team of *Advanced Materials*, in particular Dr. Marco Antonio Squillaci. I am also very grateful to the colleagues who share their great insights to this exciting special issue of *Fiber Based Materials for Smart Electronics*.