자가발전 섬유/직물 기술
-압전기
(Electricity Generating Textiles-Piezoelectric Generator)

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목차

개요

- 광범위한 자극 감지, 적합한 기능을 직물 및 의류에 제공할 수 있어 웨어러블 디바이스 및 스마트 섬유는 많은 분야에서 연구되거나 사용되고 있다. 현재 가장 잘 알려진 장치로는 운동 선수, 노약자, 환자, 소방관 및 우주 비행사의 신체 능력을 모니터링하는 것이다.

- 이러한 웨어러블 디바이스가 해결해야 할 주요 과제는 꾸준히 전원을 공급하는 것이다. 대부분의 장치들은 기존의 충전식 배터리를 사용하여 전원을 공급하고 있으나 기존의 배터리는 무겁고 부피가 크기 때문에 유연성이 떨어지거나 세탁 후 재사용이 불가능한 단점이 있다. 이러한 단점은 직물이나 의류 제품들의 고유한 특성을 이용하지 못하는 문제점이 있다.

- 의류나 직물과 같은 기판에 전력을 공급하기 위한 기존 배터리의 문제점을 해결하는 방법으로는 전력을 스스로 발생시키는 방법이 있으며 직물이나 의류는 자가 발전을 적용하기에 적합한 이점들을 가지고 있다.

- 자가 발전의 방법 중 하나로는 역학적 에너지를 전기 에너지로 바꾸는 압전 소자가 존재하며 가장 널리 연구되고 있는 방법이다.

"Energy Harvesting Materials and Structures for Smart Textile Applications: Recent Progress and Pathe Forward", Patricia I. Dolez.

압전 효과

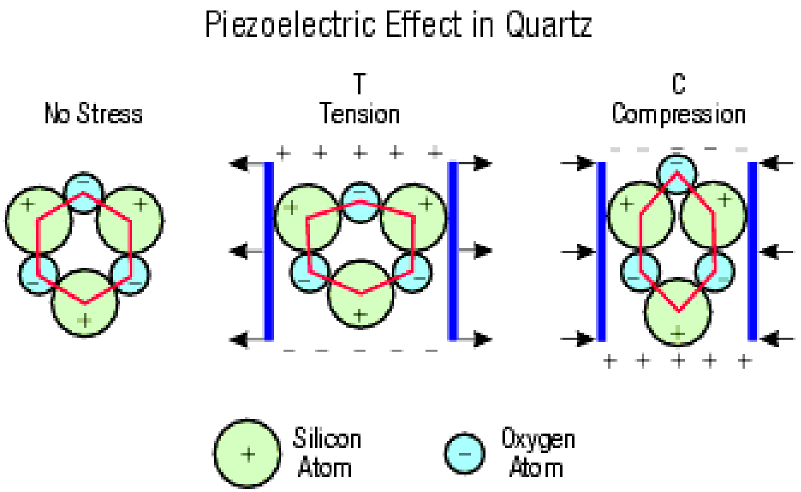

Fig 1. Piezoelectric Effect

http://www.creationscience.com/onlinebook/Radioactivity3.html

- The piezoelectric effect has mostly been investigated in regard to converting mechanical energy into electric energy.
- Of decisive importance for the piezoelectric effect is the polarization change in the piezoelectric material under a mechanical stress.
- The change in polarization appears as a variation in the surface charge density.
- They are simply constructed on piezoelectric materials and positive/negative electrodes.
- Commonly, alternating current/voltage outputs are obtained in a cycle consisting of exerting and releasing stress.
- In 2008, a fiber-shaped piezoelectric nano-generator(PENG) gave a direct output.
- Thereafter, fiber- and textile-shaped PENGs started to attract increasing attention.

섬유형 압전기(Fiber-Shaped Piezoelectric Generator)

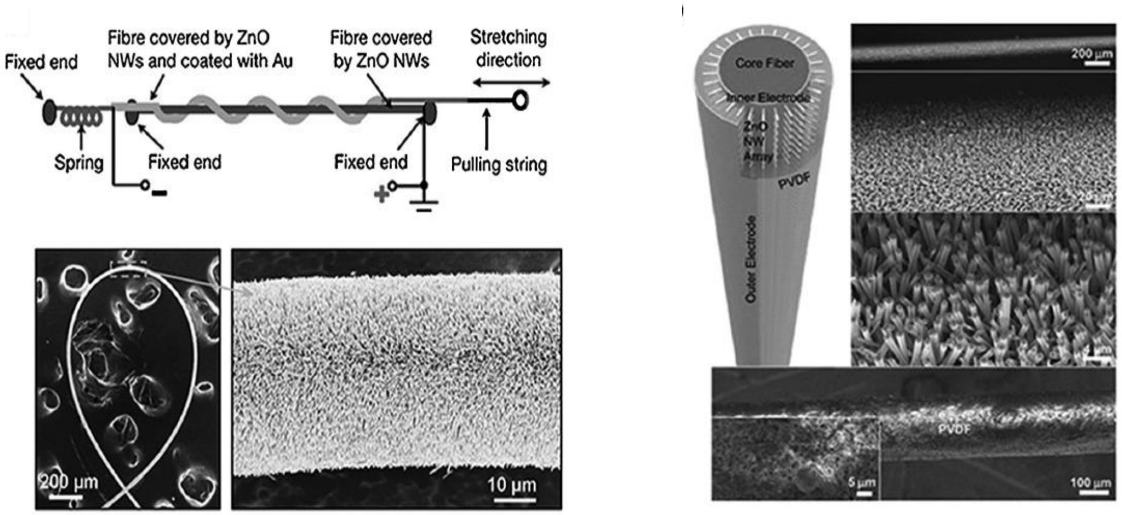

Fig 2. Fiber-shaped piezoelectric nanogenerator based on two fibers coated with ZnO nanowires(Left). Hybrid fiber-shaped piezoelectric nanogenerator based on ZnO nanowires and PVDF-coated fiber(Right)

"Smart electronic textiles" W Weng et al.

- To improve the performance, a hybrid fiber-shaped PENG was fabricated by coating a PVDF layer onto the ZnO nanowire. Here, PVDF acted as both the protective and piezoelectric material.
- An additional Au film was deposited on half of the outermost surface to serve as the other electrode for the polarization of PVDF.
- By attaching a hybrid fiber-shaped PENG with a length of 2㎝ on a human arm that folded and released through an angle of 90°, the output voltage, current density, and power density reached 0.1V, 10nA cm^{-2} , and 16mW cm^{-3} , respectively.

직물형 압전기(Textile-Shaped Piezoelectric Generator)

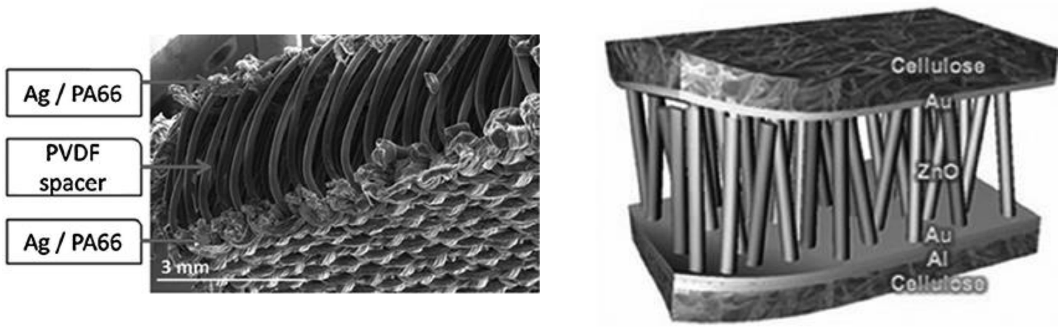

Fig 6. Cross-sectional SEM image of piezoelectric textiles with a three-dimensional spacer(Left), Schematic diagram of an integrated paper piezoelectric nanogenerator with ZnO nanorods on foldable cellulose paper(Right)

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- To enhance the performance, piezoelectric textiles were fabricated by weaving flexible piezoelectric PVDF fibers. PVDF filaments were prepared by a spinning method along with a polarization treatment.
- The PVDF filaments were then woven into a three-dimensional spacer fabric, which was sandwiched between silver-coated polyamide layers that acted as the top and bottom electrodes to produce a piezoelectric textile.
- Paper was also studied as a promising substrate for the PENG, typically with a sandwich structure, that is, a metal-coated cellulose paper at the bottom, ZnO nanorods in the middle, and Au-coated cellulose paper at the top.
- Power densities of 1.10–5.10 mWcm-2were generated under pressures of 0.02–0.10 MPa.
- It generated electricity under a pushing force perpendicular to the PENG, with an output current density of approximately 2.0 mAcm-2.

참고문헌

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