# 자가발전 섬유/직물 기술
# -태양 전지

(Electricity Generating Textiles-Solar Cell)

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# 목차

# 개요

- 웨어러블 디바이스와 e-textile에 있어서 전력 공급은 주요한 해결 과제이다. 기술의 발전으로 낮은 전력에서도 구동되는 장치가 개발되었지만, 현재 사용 가능한 기술은 상대적으로 집약적인 전력이 필요하다. 또한 대부분의 웨어러블 디바이스 제품은 기존의 충전식 배터리로 구동되고 있는 실정이다.

- 하지만 이런 기존의 배터리는 무겁고 부피가 크기 때문에 직물/의류에 장착하거나 통합되어 사용하기에는 유연성이 떨어지고 반복적인 세탁을 할 수 없어 직물 고유의 특징을 잃게 하는 문제점이 발생한다.

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

- 태양광 자가 발전 기술에는 고효율 무기 필름, 유기 소자 필름, 염료 감응 태양 전지, 태양광 발전이 가능한 섬유를 이용한 기술들이 존재한다.

*“Energy Harvesting Materials and Structures for Smart Textile Applications: Recent Progress and Path Forward”, Patricia I. Dolez*

# 섬유형 태양전지(Fiber-Shaped Solar Cell)

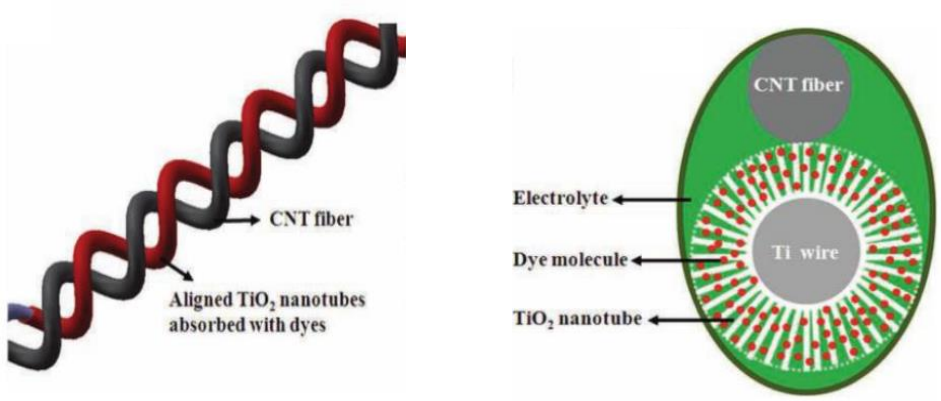


Fig 1. Twisted fiber-shaped dye-sensitized solar cell based on Ti wire and a CNT fiber

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- Aligned $TiO_2$ nanotubes were directly grown onto and more stably adhered to the titanium wire(Fig 1).
- However, when the two metal wires were twisted together, gaps existed between them, which resulted in low efficiencies and poor stabilities.
- The fiber-shaped DSSCs were typically made from liquid electrolytes, which may leak and decrease the efficiency and stability.
- Quasi-solid-state electrolytes were used in recent years to replace the liquid electrolytes to increase the stability, but the efficiency was greatly decreased to 3.51%.

# 섬유형 태양전지(Fiber-Shaped Solar Cell)

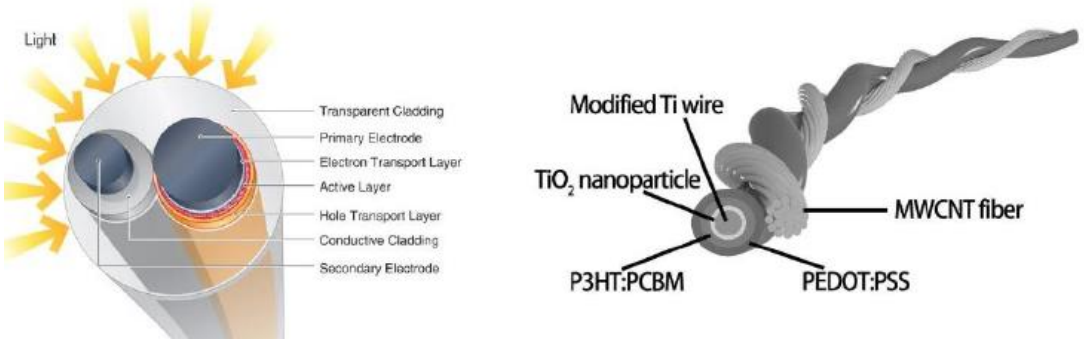


Fig 2. Twisted fiber-shaped polymer solar cell.

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- To further increase the stability and efficiency, all solid-state polymer solar cells have also been incorporated into fibers(Fig 2).
- Typically, a fiber-shaped polymer solar cell was fabricated by twisting a photoactive polymer coated core electrode through a continuous solution process with another electrode, and an efficiency of 3.8% was achieved.
- Nevertheless, the efficiency of the fiber-shaped polymer solar cell needs to be further enhanced for practical applications, and a lot of effort is currently being made to develop new fiber electrodes and optimize the cell structure.

# 섬유형 태양전지(Fiber-Shaped Solar Cell)

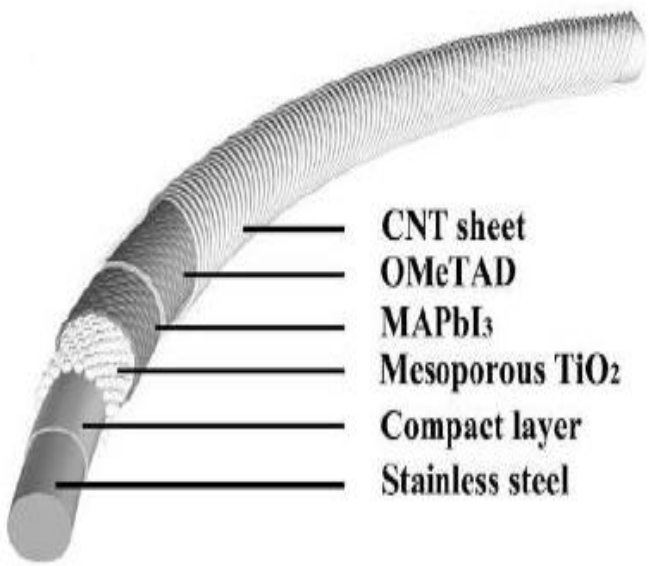


Fig 3. Coaxial fiber-shaped perovskite solar cell.

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- Recently, the perovskite solar cell rose as a new star of photovoltaic devices because of its much higher efficiency than both DSSCs and polymer solar cells(Fig 3).
- A coaxial fiber-shaped perovskite solar cell was achieved by sequentially coating a compact layer, a meso-porous $TiO_2$ layer, and a perovskite $CH_3NH_3PbI_3$ sensitizer onto a stainless steel wire electrode, followed by coating with the hole-transport material and winding around a transparent CNT sheet as the cathode.
- An efficiency of 3.3% was produced, and this value was expected to increase after optimization, such as by the introduction of new electrode materials.
- Besides designing new photoactive layers and achieving high efficiencies, stretchable fiber-shaped solar cells have also been proposed to expand their application scope.

# 섬유형 태양전지(Fiber-Shaped Solar Cell)

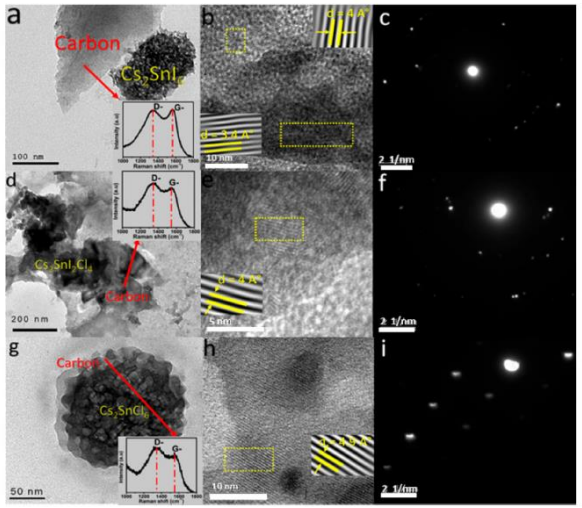


Fig 4. Examples of recent developments toward photovoltaic energy harvesting materials and structures for textile application: image by high-resolution transmission electron microscopy of double perovskites after annealing: $Cs_2SnI_6$ (a–c), $Cs_2SnI_2Cl_4$ (d–f), $Cs_2SnCl_6$ (g–i)

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- A strategy explored by researchers to increase the level of conversion relies on electro-spun fibers.
- Single-phase electro-spun double perovskite nano-fibers were prepared using iodide and chloride. A layer of graphene oxide formed during the annealing process (Figure 4), which decreased the band-gap energy.
- The best results were obtained for perovskite with a mix iodide and chloride ions.
- New developments with the counter electrode for a fiber solar cell configuration was made using a carbon nanotube yarn. A slight increase in the power conversion efficiency was obtained with 4% as compared to 2.64% with platinum as a representative to the noble metals traditionally used.

# 직물형 태양전지(Textile-Shaped Solar Cell)

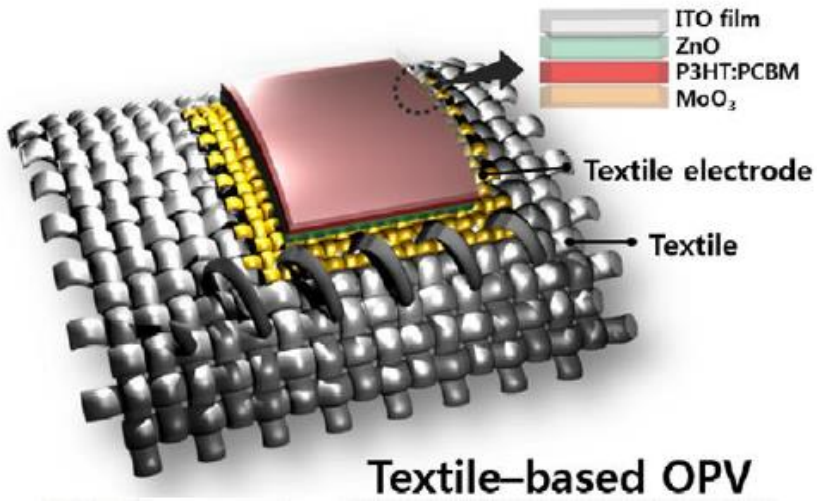


Fig 4. The fiber-shaped perovskite solar cells

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- Photovoltaic textiles can either be woven from fiber-shaped solar cells or they can also be directly fabricated from textile substrates based on polymer fibers.
- Recently, a reduced graphene oxide was coated on a cotton fabric to act as the counter electrode in a DSSC that achieved a higher efficiency of 2.52%
- Aligned CNT fibers have been widely studied because of their combined high electrical conductivity, tensile strength, and catalytic activity.

# 참고문헌

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