섬유/직물 기반 전자 저장 장치 Ⅰ
(Textile for Electricity Storage Ⅱ)

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목차

개요

- 일반적으로 사용하는 리튬 이온 배터리(lithium-ion batteries, LIBs)와 슈퍼캐퍼시터(super-capacitors, SCs)는 다층 구조로 쌓인 금속박 전극으로 제조된다.
- 최근 다양한 물질로 합성된 섬유/직물 기판 배터리들이 연구되고 있으며, 그 이유는 유연한 LIBs와 SCs를 섬유 전극으로 실현할 수 있기 때문이다. 특히 섬유/직물 기판으로 된 전극은 표면적이 크고 가벼우며 유연성이 뛰어나고 탄성이 균일한 복합 전극을 생산할 수 있는 장점을 가지고 있다.
- 또한 이러한 섬유/직물 전극은 에너지 저장 장치에 추가적인 통기성과 3차원적 적합성의 장점을 제공할 수 있어 웨어러블 디바이스 분야로 적용하기에 매력적이다.
- 이러한 섬유 전극은 유연성과 고용량의 성능을 지닌 섬유/직물 기반 에너지 저장 장치를 만들 것이라고 기대되고 있다.

"Textile Composite Electrodes for Flexible Batteries and Supercapacitors: Opportunities and Challenges", Y. Gao et al.

리튬 이온 배터리(Lithium Ion Battery)

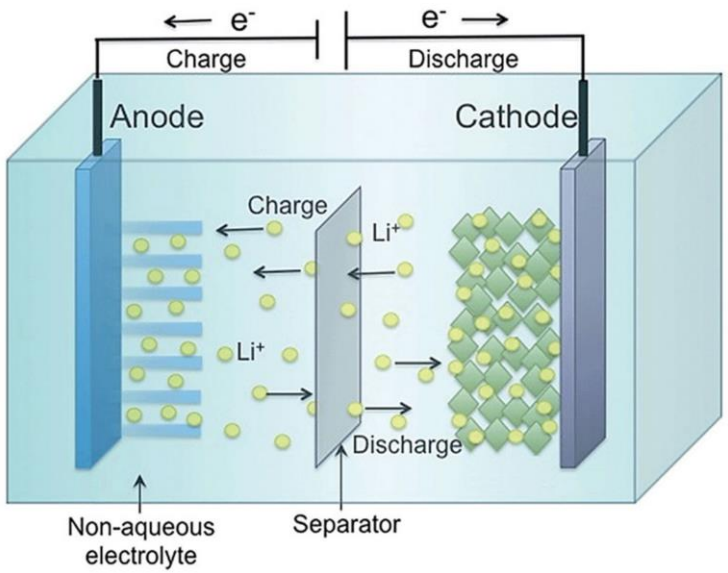

Fig 1. The principle of the lithium-ion battery(LIB)

"Smart electronic textiles" W Weng et al.
"A Review of Lithium-Ion Battery Fire Suppression", M. Ghiji et al.

- A lithium ion battery consists of a negative electrode, a positive electrode, and an electrolyte. For a typical working process, lithium ions move from the negative electrode to the positive electrode during discharging and in the reverse direction during charging.
- The electrolyte allows ionic transport between the negative and positive electrodes. The binder is made of thermoplastic polymers, and conductive additives are made of carbonaceous materials such as carbon black, CNTs, and graphene.
- To prepare an electrode, a slurry of active material, binder, and conductive additive is formed first and then cast onto a current collector. This preparation process is compatible with conventional rigid planar batteries but becomes difficult for flexible battery fibers and textiles, as rigid current collectors and electrodes are typically used.

섬유형 리튬 이온 배터리(Fiber-Shaped Lithium Ion Battery)

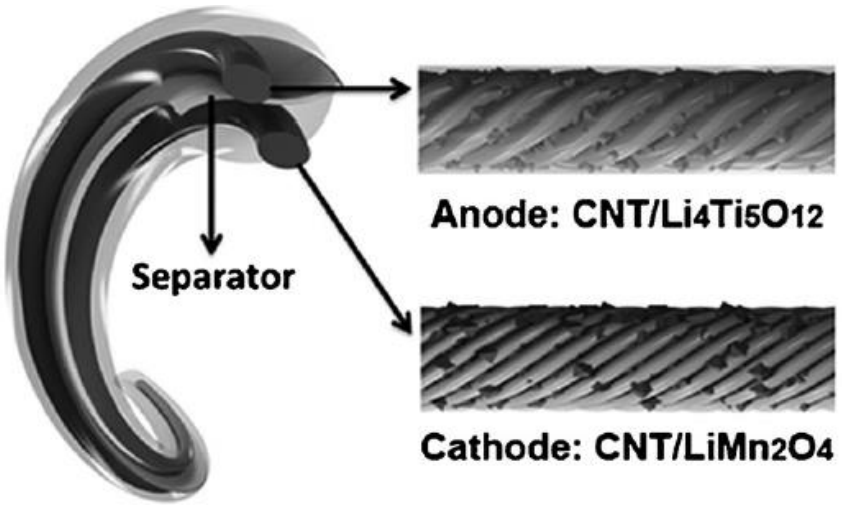

Fig 2. Structure of a flexible fiber-shaped lithium ion battery based on aligned CNT/$Li_4Ti_5O_{12}$ and CNT/$LiMn_2O_4$ composite fibers as the anode and cathode, respectively.

"Smart electronic textiles" W Weng et al.

- A variety of aligned CNT-based fibers were then developed to replace the metal materials. As previously mentioned, aligned CNT fibers display both high electrical conductivity and tensile strength, and they can be used to coat metal oxide and silicon on the surfaces of CNTs.

- To expand the application scope of the fiber-shaped batteries, it is necessary for them to be both elastic and flexible so that they can work effectively in wearable electronics during a stretching movement.

- A stretchable fiber-shaped battery can be produced if an elastic polymer fiber is used as the substrate instead of a cotton fiber. Flexible fiber-shaped batteries were first fabricated by pairing aligned CNT/Li4Ti5O12and CNT/LiMn2O4composite fibers as the anode and cathode, respectively.

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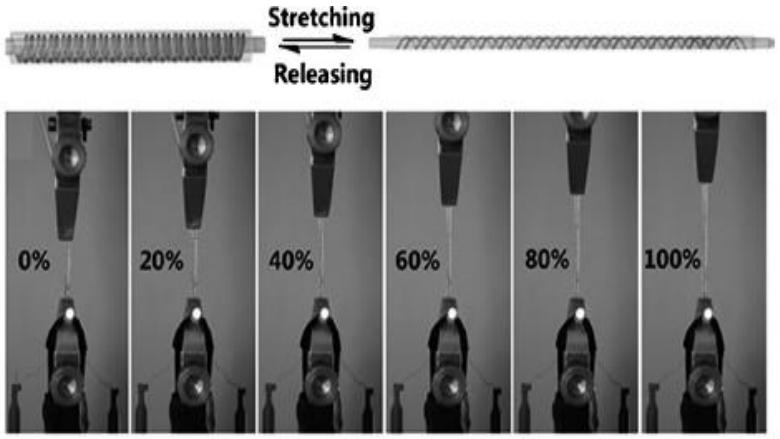

Fig 3. Stretchable fiber-shaped lithium ion battery on an elastic polymer fiber substrate that powers a light-emitting diode as the strain increases.

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- Flexible fiber-shaped batteries were first fabricated by pairing aligned CNT/Li4Ti5O12 and CNT/LiMn2O4 composite fibers as the anode and cathode, respectively(Figure 2). The cathode and anode fibers were assembled in parallel and wrapped onto the heat-shrinkable tube(Figure 3), followed by coating a thin layer of gel electrolyte and inserting into another heat-shrinkable tube.
- However, the elastic substrate increased the weight and volume as well as decreasing the specific capacity In addition, the low tensile strength and low thermal stability of the elastic polymer limited their applications. Therefore, it was necessary to further realize stretchable fiber-shaped batteries without using elastic substrates.
- As expected, the fiber-shaped batteries could be further woven into energy-storage textiles.

참고문헌

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