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Fabrication of Electronic Textiles with Various Integrated Electronics

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Introduction

E-textiles have received a lot of attention in recent years because they combine the traditional advantages of textiles with electric components. However, the textile's breathability and flexibility will be severely compromised when rigid and bulky electronics are attached. Alternately, preserving the inherent advantages of fabrics while incorporating functional fibers into conventional fabrics is a versatile and promising strategy. However, there is currently no practical method for incorporating smart fibers into textiles. A coaxial spinneret-equipped 3D printer is used to create core-sheath fiber-based smart patterns on textile for E-textile, which we report here can be easily made in one step. The demonstrated energy management and other applications of the printed smart pattern on textile go beyond the conventionally aesthetic or trademark identification of patterns and pave the way for simple E-textile fabrication with various integrated electronics.

Description

Development of flexible and wearable electronics in recent years, the term "electronic textile" (E-textile) has received a lot of attention. Using a coaxial spinneret-equipped 3D printer, we report the direct printing of an E-textile made of core-sheath fibers in this paper. Printing patterns made of core-sheath fiber can be done on textiles for a variety of purposes. We demonstrated by fabricating a core-sheath fiber-based smart pattern with a conductive core made of carbon nanotubes (CNTs) and a dielectric sheath made of silk fibroin (SF). This textile was then used as a triboelectricity nanogenerator. The smart textile could use human motion to generate biomechanical energy and have a power density of up to 18 mW/m_2. Additionally, we demonstrated the printing of an energy-storing supercapacitor textile. The large-scale production of self-sustaining electronic textiles with integrated electronics may benefit from the direct printing of smart patterns onto textiles.

Beyond the desired electronic functions, electronic textile (E-textile), also known as a textile or fabric with integrated digital components, has the potential to inherit softness, breathability, and stretchability from conventional fabrics. Fibertronics, on the other hand, are a versatile and promising way to obtain E-textile while maintaining the aforementioned benefits of fabrics.4 As a result, the development of techniques to fabricate smart fibers with built-in or add-on electronic functionality attracts significant attention. However, imparting desired functions to highly deformable fibers remains a significant technical challenge.1 On the other hand, practical approaches to integrate smart fibers with textile are still lacking. However, the attachment of rigid electronics to textile A functional circuitry on cotton yarns was reported by coating a layer of aluminum using dip-coating and a layer of polymer by chemical vapour deposition, followed by being woven into fabrics. Although these approaches are effective, the processes are still complex and time-consuming. For example, a recent work reported the fabrication of an organic light-emitting diode (LED) fiber through multi-step dip-coating and thermal deposition, followed by being sewn into fabrics. Therefore, fibertronics fabrication procedures that are simple or even one-step in nature and have the potential for mass production are highly desired.

In particular, a 3D printing technique based on direct ink writing was demonstrated to be an effective method for fabricating fiber-based architectures for soft robotics, smart composites, and stretchable electronics. Currently, a single-axial spinneret is typically used for 3D printing, restricting the material selection and structure design of the printed architectures. We anticipate that the introduction of the multi-axial spinneret will significantly expand the capabilities of 3D printing methods, particularly for the production of smart textiles and multifunctional fibers.

Using a coaxial spinneret-equipped 3D printer, we demonstrate the one-step fabrication of fiber-based smart patterns for E-textile in this paper. The examples comprised of center sheath filaments, which were expelled from a coaxial spinneret and were straightforwardly imprinted on material by a 3D printer. The ability to easily select the precursor materials for the core and sheath fibers allows for the production of versatile, functional E-textiles that can be used for a variety of applications. We printed core-sheath fiber-based patterns on textile using carbon nanotubes (CNTs) as the core fiber and silk fibroin (SF) as the sheath layer as a proof of concept. In addition, we demonstrated how well our smart textile worked as a triboelectricity Nano generator to extract mechanical energy from human motion. Additionally, an energy-storing smart super capacitor textile was demonstrated. E-textiles with a variety of integrated electronics can be easily made thanks to the direct printing of smart patterns onto textiles [1-5].

Conclusion

A coaxial spinneret that was mounted on a 3D printer was connected to two injection syringes containing distinct inks. The final power devices' desired functions can determine which inks contain various materials. E-textile's practical applications should take into account the sheath materials' flexibility, biocompatibility, and waterproofness. We used SF solution as the sheath ink and CNT aqueous solution as the core ink for demonstration purposes. Based on this, we created an E-textile for wearable energy management that can collect mechanical energy from human movement. Core-sheath structured fibers were produced when the inner spinneret's CNT ink and the outer spinneret's SF ink were injected simultaneously. In order to guarantee that the flow rates of the CNT and SF inks would be comparable, different feeding rates were used due to the distinct cross-sectional areas of the inner and outer spinnerets. The coaxial spinneret's speed must match the fiber's rate of extrusion in order to produce durable, continuous fibers on textiles.

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