Graphene for textile triboelectric nanogenerators

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With the emergence of wearable technologies and the high demand of flexible organic devices, there is a strong need in investigating self-powered electronics and carbon-based materials due to their high natural abundancy. This will satisfy a key requirement for commercialisation, which is cost-effective manufacturing. Moreover, as electronic systems are showing significant advancements, it is believed that the power requirements of typical e-skin devices will be in the range of microwatts. This renders the human body a continuous and an environmentally friendly source of mechanical and thermal energy.
Graphene is a material of choice in this case because of its remarkable high thermal, electrical and mechanical properties, allied to its flexibility and lightweight. These properties will be crucial in the integration of graphene on textiles.
Following our previous work demonstrating wearable devices and humidity sensors made with graphene [1]-[3], as well as graphene triboelectric nanogenerators (TENGs) [4], this work shows the steps toward integrating these two technologies into self-powered devices capable of powering up an organic sensor using mechanical energy. Moreover, two types of graphene transfer methods have been utilised in obtaining electrodes for our TENG devices; which include spray coating of graphene ink [5] and chemical etching of graphene synthesised by Chemical Vapour Deposition (CVD). These TENGs are capable of scavenging energy from human motions as well as being an independent and continuous type of energy compared to solar and thermal energy. Triboelectricity is a phenomenon that occurs between two materials that get statically charged when they become in contact with each other as a result of electrons and ions exchanges which are electrostatically induced. In order to achieve flexibility, various polymer dielectrics (triboelectric materials) such as polydimethylsiloxane (PDMS) have been investigated with graphene acting as an electrode. These polymers would allow a continuous friction and/or contact separation with different fabrics such as polyester and nylon when implemented as textile wearable devices. Furthermore, surface functionalisation of these polymers consists of exposing PDMS to sulfur hexafluoride (SF_6) plasma to fluorinate its surface in order to improve triboelectrification, as highlighted in Figure 1.

Figures

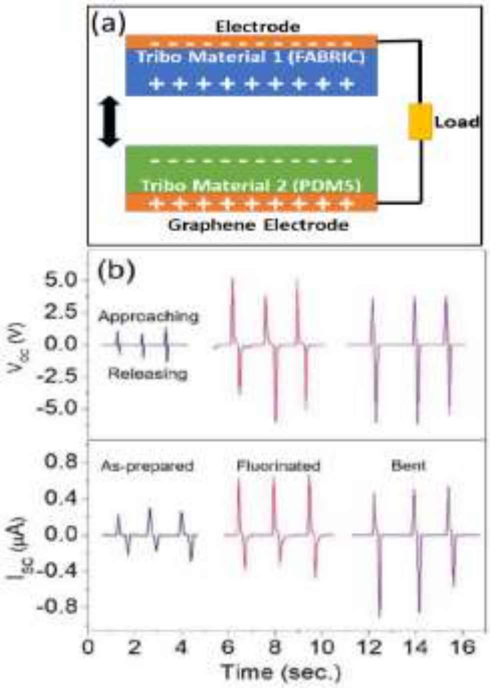

Figure 1: (a) Structure of a TENG device. (b) Open-circuit voltage and closed-circuit current of graphene based TENG with fluorinated PDMS and bending effect [4].

References

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