Hybrid Graphene Electrode for High-Performance Ionic Actuators

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Abstract

Ionic actuators have recently drawn an extensive attention owing to remarkable performance under low voltage stimulation [1]. The increasing demands for ionic actuators urgently call for development of new flexible electrodes [2]. Here we report a novel hybrid graphene electrode for utilization in ionic actuators. In this electrode a new type of graphene structure, called graphene mesh (GM), was merged with nitrogen-doped graphene (NG) to enhance the electro-chemical and electro-mechanical features of the actuator. Our newly synthesized graphene mesh showed superior electrical conductivity of 6.38×10^{-4} S/cm. Adding GM to the NG electrode significantly improved the electrical conductivity of the electrode by 67 times and decreased the electrical resistance to 13.26 Ω/sq. Employing the well-designed GM-NG electrode also enhanced the performance of actuator by 620%. This outstanding enhancement mostly attributes to exceptional properties of high quality GM. A mesh type network of hollow graphene tubes is distributed in whole electrode, like blood vessels in human body, and transfers the charges to all portions of electrode swiftly and uniformly. While GM facilitates the charge transfer, NG flakes provide high specific capacitance for charge storage. This is the first time that such hybrid graphene electrode is introducing and its utilization in other applications could open a new vista in the field of soft electronics.

References

[1] O. Kim, et al. Nature Communications. 4 (2013) 2208.
[2] Y. Yan, et al. Advanced Materials. 29 (2017) 1606109.

Figures

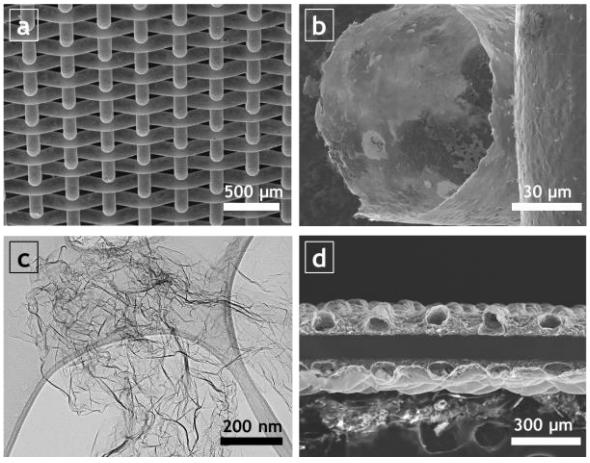

Figure 1: a, b) SEM images of GM, c) TEM image of NG, d) SEM cross-sectional view of the actuator with hybrid GM-NG electrode.

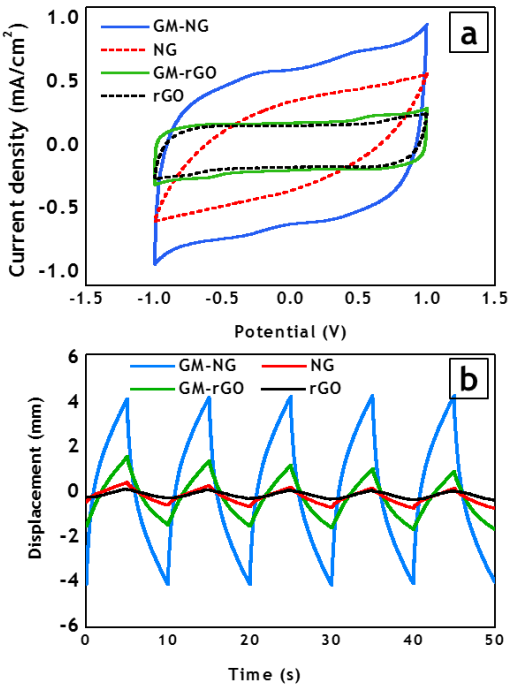

Figure 2: a) CV test of electrodes showing improved electro-chemical activity of GM-NG electrode. b) Actuators response of different electrode under 0.1 Hz square-wave input.