Scalable Fabrication of Graphene-based Textile Supercapacitors by Mimicking an Industrial Process

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Graphene-based electronic textiles have drawn significant research interest as the potential components for low-cost multi-functional flexible and wearable electronics for sportswear, military and health care applications [1]. One of the key challenges to integrate these electronic devices to textiles is the requirement of being lightweight, flexible and high performance power supply unit [2]. Flexible supercapacitors are promising energy storage device that can meet these requirements while maintaining the same electrochemical properties such as high power density, longer life cycles, and quick charge/discharge [3]. Recently graphene (G) has been focus of much investigation for energy storage application due to its extremely high specific surface area, excellent mechanical properties, and high thermal and electrical conductivity [4]. However, majority of the textile supercapacitors reported are based on reduced graphene oxide (rGO) and could only be produced at laboratory scale. Here we report a simple, scalable and cost-effective vacuum filtration and padding method for fabricating e-textiles electrodes for flexible supercapacitors application. To our best knowledge, we report for the first time the use of electrochemically exfoliated G for textile supercapacitors.

Both electrochemically exfoliated Graphene (G) and rGO were ultrasonically dispersed in Isopropanol/water 50/50 V.% solution. Then, Polyester-Cotton (PC) and Cotton (C) fabrics were padded using both G and RGO dispersion and dried in oven at 150°C for 15 minutes. The quality of both G and rGO were assessed by XPS and Raman spectroscopies. As prepared samples were characterized by SEM and Raman to evaluate the dispersion of active materials in the fabric. Fabrics were dip-coated into a gel electrolyte. Three gels were tested: PVA-LiCl, PVA-H_3PO_4, and PVA-KOH. Electrochemical characterizations were performed afterwards to evaluate the performance of the coated fabrics.

XPS and Raman confirmed the exfoliation of the G and the reduction of rGO. SEM images of the PC and C fabrics show a homogeneous dispersion after the padding procedure. Complete electrochemical characterizations demonstrate significant results for textile supercapacitors applciations.

For the first time, a padding procedure mimicking an industrial process allows to obtain textile with suitable power sources for e-textile applications. Moreover, this procedure uses directly G as active material while previous research in this field was focused on rGO.

References

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