Electrochemical synthesis of metal sulfide/3D-graphene composites for energy storage applications

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Electrochemical synthesis is a powerful tool for the fabrication of nanostructured materials such as metal/alloy plating and oxide/sulfide semiconductors. Especially, direct electrodepositing functional materials on conductive substrates has attracted intensive attention for battery, supercapacitor and electrocatalysis application. In this work, we report a two-step approach combining electrophoretic deposition (EPD) and cathodic electrodeposition (CED), to fabricate multilayer hierarchical electrodes (Figure 1) of reduced graphene oxide (rGO) and mixed transition metal sulfides ($NiCoMnS_x$, NCMS) [1,2]. The process is performed directly on conductive electrodes applying a small electric bias to electro-deposit rGO and NCMS in alternated cycles, yielding an ideal porous network and a continuous path for transport of ions and electrons. A fully rechargeable alkaline battery (RAB) assembled with such electrodes gives maximum energy density of 97.2 Wh kg^{-1} and maximum power density of 3.1 kW kg^{-1}, calculated on the total mass of active materials, and outstanding cycling stability (retention 72% after 7000 charge/discharge cycles at 10 A g^{-1}). The approach can be used to assemble multilayer composite structures on arbitrary electrode shapes.

References

[1] Sanchez J. S., Xia, Z. Y., Patil, N., Grieco, R., Sun, J. H., Klement, U., Qiu, R., Christian, M., Liscio, F., Morandi, V., Marcilla, R., Palermo, V., Small, 18 (2022), 2106403
[2] Sanchez, J. S., Xu, J., Xia, Z. Y., Sun, J., Asp, L. E., Palermo, V. Composites Science and Technology, 208 (2021):108768

Figures

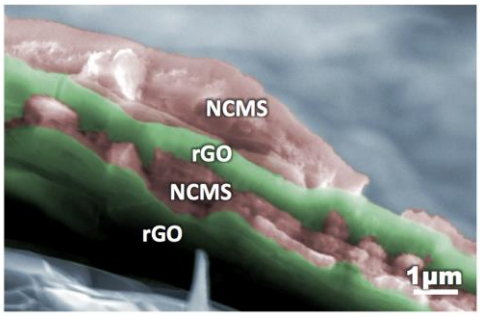

Figure 1: SEM image of the multilayer rGO/NCMS structure.