Graphene composites as advanced electrodes for high performance metal-ion hybrid supercapacitors

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This presentation will showcase different strategies followed for the preparation of graphene-based composites and their use as electrodes in metal-ion hybrid supercapacitors.

Among them, we will focus on a simplistic approach for the synthesis of nitrogen-doped graphene decorated with Sn particles, suitable as battery-type electrode,[1] and the preparation of an activated carbon derived from a graphene–carbon composite, which served as capacitor-type electrode.[2] The excellent features of the nitrogen-doped graphene matrix combined with the homogeneous distribution and high theoretical capacity (994 mAh g^{-1}) of the submicrometer-sized Sn particles leads to an improved performance of the negative electrode, especially at high current densities.

An optimized dual-carbon lithium-ion capacitor with 2:1 positive to negative mass ratio delivers high energy and power densities (133 W h kg^{-1} at 142 W kg^{-1} and 51 W h kg^{-1} at 25 600 W kg^{-1}). Furthermore, within a discharge time of 1 min, the device reaches 19 000 cycles with full capacity retention, delivering ca. 100 W h kg^{-1} at 5600 W kg^{-1}.

Additionally, these anodes were also tested in combination with graphene-faradaic materials to achieve high energy densities at low power rates.[3]

Acknowledgements

This work is part of the R&D&I project PID2021-127635OB-I00, funded by MCIN/AEI/10.13039/501100011033 and by "ERDF A way of making Europe", by the European Union.

References

[1] M. Granados-Moreno et al., Sustainable Energy Fuels, 6 (2022) 700-710
[2] G. Moreno-Fernández et al., Batteries & Supercaps, 4 (2021) 469 -478
[3] M. Granados-Moreno et al., Sustainable Energy Fuels, 7 (2023) 965-976