Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

Microstructured nitrogen-doped graphene-Sn composites as negative electrode for high performance lithium-ion hybrid supercapacitors

Miguel Granados-Moreno[a], Gelines Moreno-Fernández*[,a], Rosalía Cid[a] , Juan Luis Gómez-Urbano[a,b], Daniel Carriazo*[,a,c]

[a] Centre for Cooperative Research on Alternative Energies (CIC energiGUNE), Basque Research and Technology Alliance (BRTA), Alava Technology Park, Albert Einstein 48, 01510 Vitoria-Gasteiz, Spain.

[b] Universidad del País Vasco, UPV/EHU, 48080 Bilbao, Spain

[c] IKERBASQUE, Basque Foundation for Science, 48013 Bilbao, Spain

*Corresponding authors, Tel: +34 94 529 71 08; E-mail: mamoreno@cicenegigune.com, dcarriazo@cicenergigune.com

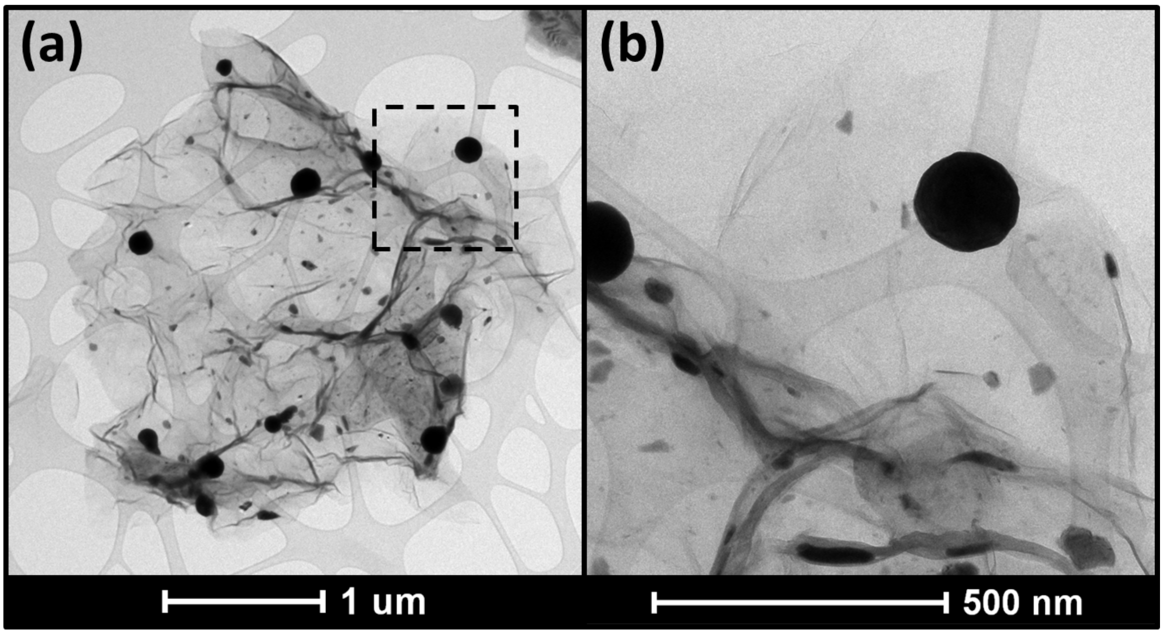

Fig. S1. TEM images registered for rGO800-N-Sn sample at different magnifications.

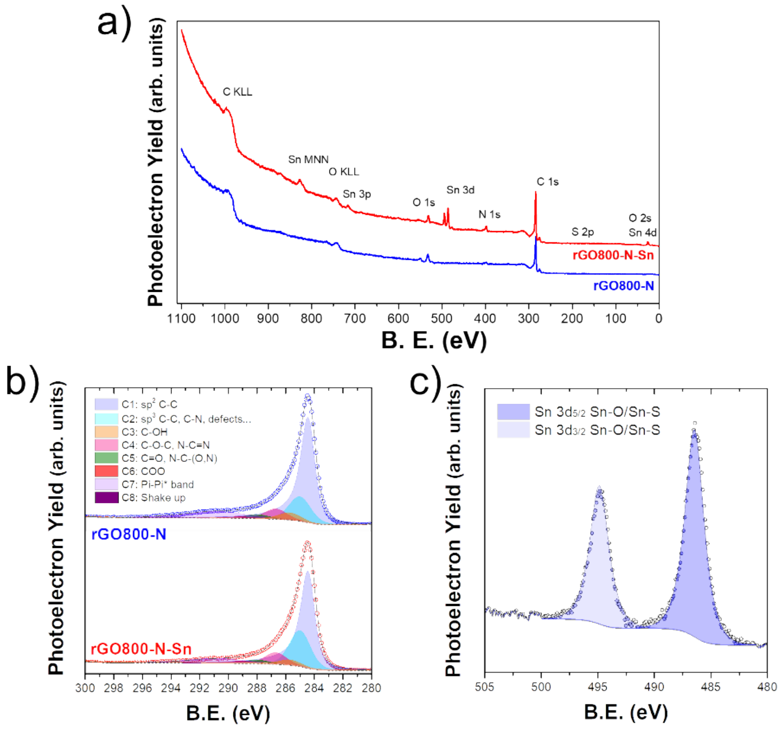

Fig. S2. XPS survey spectra (a), C 1s high resolution region (b) for rGO800-N and rGO800-N-Sn and (c) Sn 3d high resolution spectrum of rGO800-N-Sn. The 3d spin-orbit splitting and binding energies of Sn $3d_{5/2}$ and Sn $3d_{3/2}$ core levels correspond to Sn oxides or sulphides,[1] indicating that the outermost surface of the metallic Sn particles contains a very small amount of oxide undetectable by XRD or some residual tin oxide/sulphide is present in the surface of the as-synthesized materials.

Table S1 Surface elemental composition of the battery-type materials determined by XPS. The amount of Sn in the surface is significantly smaller than in the bulk (Table 1), suggesting that the Sn nanoparticles are somewhat buried taking into account the small probing depth of the XPS (less than 10 nm).

	C (%)	S (%)	Sn (%)	O (%)	N (%)
rGO800-N	89.3	---	---	6.7	4.0
rGO800-N-Sn	85.5	0.4	1.0	6.4	6.1

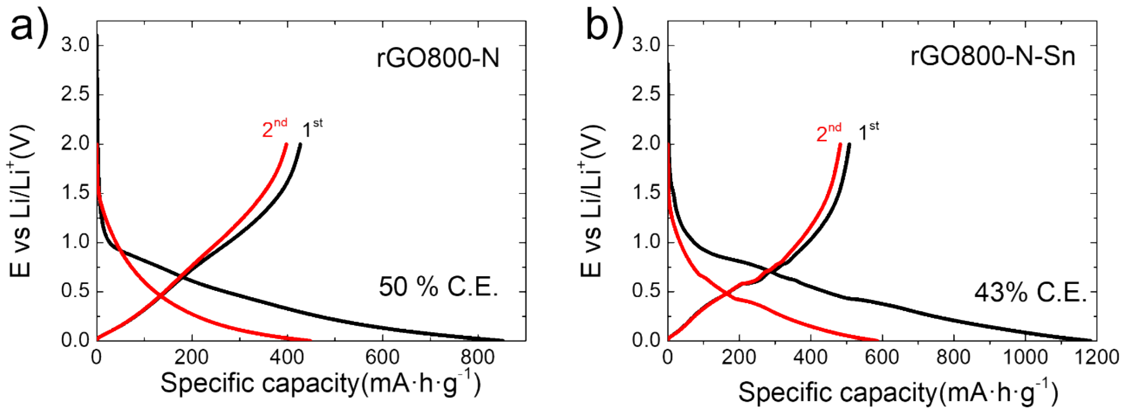

Fig. S3. Galvanostatic charge/discharge curves for the first and second cycle for rGO800-N (a) and rGO800-N-Sn (b). Indexed: coulombic efficiency of the first cycle (C.E.)

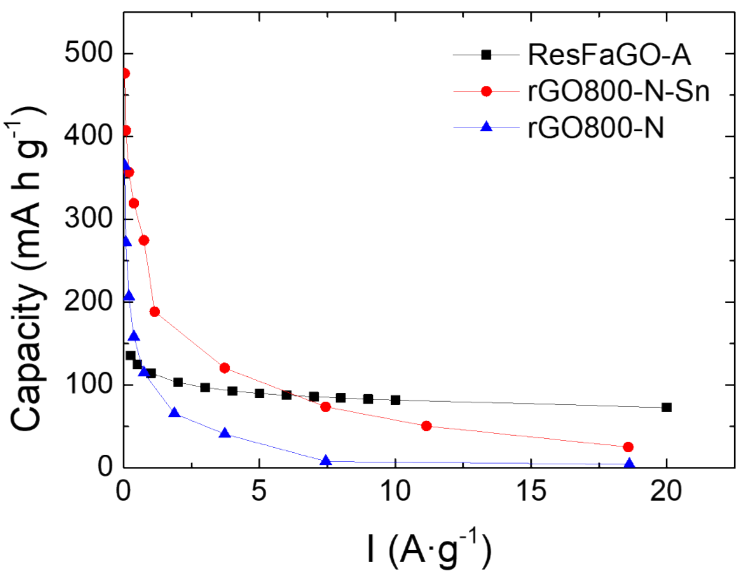

Fig. S4. Rate capability of ResFaGO-A positive electrode in the potential range 1.5-4.2 V vs Li/Li^+ and rGO800-N and rGO800-N-Sn negative electrodes in the potential range 0.002-2 V vs Li/Li^+

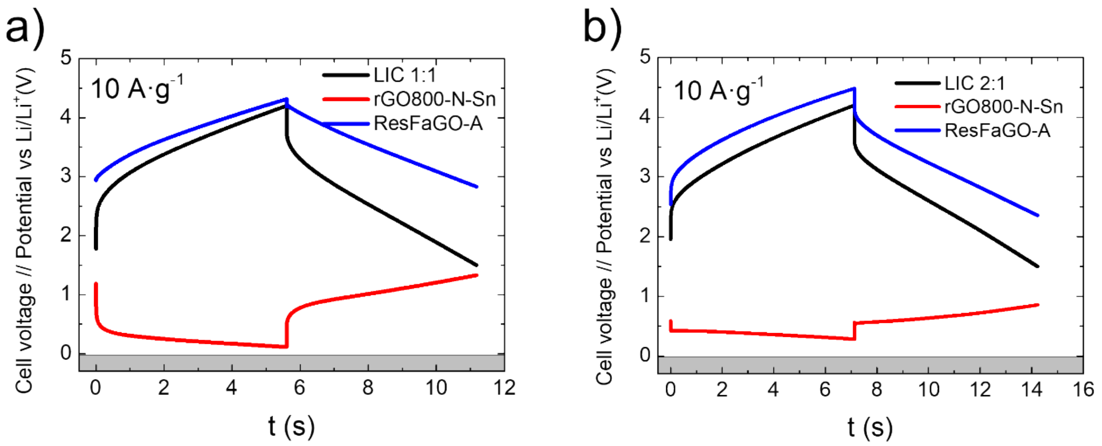

Fig. S5. Galvanostatic charge/discharge profiles at 10 $A\cdot g^{-1}$ LIC1:1_rGO800-N-Sn (a) and LIC2:1_rGO800-N-Sn (b): LIC (black), negative electrode (red) and positive electrode (blue).

REFERENCES

1 J. C. C. Fan and J. B. Goodenough, *J. Appl. Phys.*, 1977, **48**, 3524–3531.