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Electronic Supporting Information

Rattle-type $NiCo_2O_4$-carbon composite microspheres as electrode materials for high-performance supercapacitor

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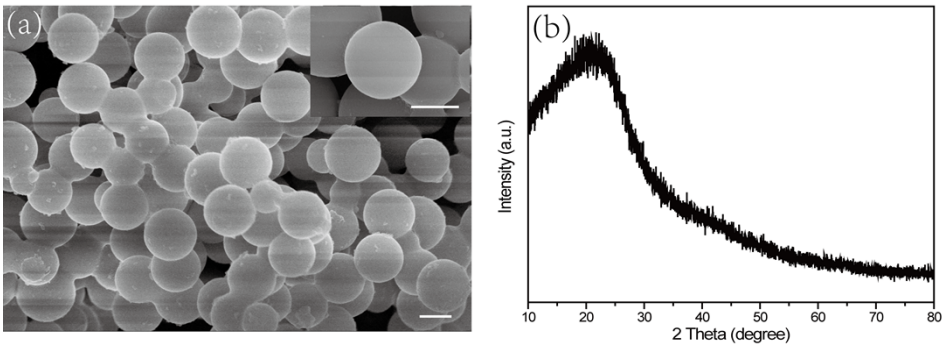

Fig. S1 (a) FESEM image and (b) XRD pattern of as-prepared colloidal carbon microspheres. The length of the bar shown in (a) is 1μm.

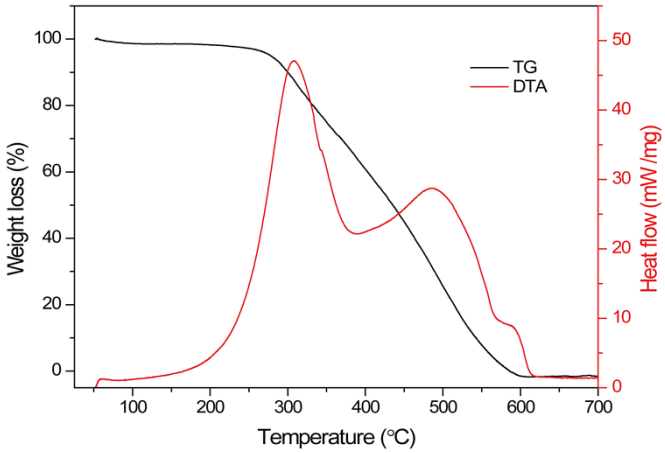

Fig. S2 TG and DTA curves of the as-synthesized carbon microspheres.

Fig. S2 shows the TG-DTA curves of the carbon microspheres. It can be clearly seen that the main weight loss occurred from 200 to 600 ℃, corresponding to the major exothermic peak. From the DTA curve, it can be inferred that the loss of the carbon microspheres may include three steps because the exothermic peak clearly shows different combustion kinetics of template. In detail, during the calcination over 200 and 380 ℃, the outer part of templates can be easily removed owing to the exposing them in air[1]. With the calcination time increasing, the formation of $NiCo_2O_4$ shell is not match with the removal of carbon microspheres, which results in the separation of outer shell and inner carbon core. This result is consistent with the SEM analysis (Fig. 3d). Thus, it can be speculated that the core-shell structure of the $NiCo_2O_4$-carbon structure was formed when the calcination temperature was 250 ℃. The two other exothermic phases are assigned to the combustion of the polyfuranic structure and aromatic networks, respectively[2].

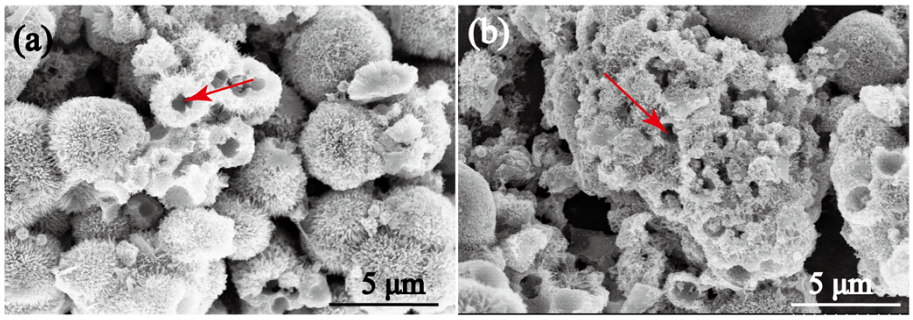

Fig. S3 FESEM images the as-prepared $NiCo_2O_4$ microspheres after calcination at different temperature: (a) 300 ℃ and (b) 400 ℃.

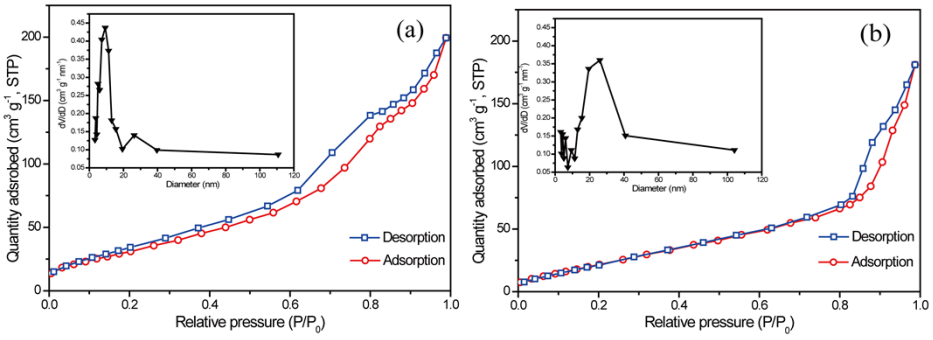

Fig. S4 N_2 adsorption-desorption isotherms of the samples calcinated at (a) 300 ℃ and (b) 400 ℃: the inset is the corresponding pore size distribution.

References

1. Y. Sun, L. Zhang, J. Zhang, P. Chen, S. Xin, Z. Li and J. Liu, *Ceramics International*, 2014, 40, 1599.

2. C. Falco, N. Baccile and M.-M. Titirici, *Green Chemistry*, 2011, 13, 3273.