Tunable fabrication of core-shell Ni-MnO$_2$ hybrid foams through structure-guided combustion waves for binder-free high-performance supercapacitor electrodes

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Fig. S1 Atomic percent of carbon (C) as a function of the application number of SGCWs. Variation in the carbon atomic percent of the carbon-coated Ni foams as a function of the number of SGCW applications. The carbon atomic percent was measured by XPS analysis.

Fig. S2. Uniformity of the Ni-foam carbon coatings obtained by applying SGCWs for different number of times. XRD patterns of the foams of Ni@C, synthesized by the SGCWs in (a) three-times and (b) one-time SGCW-applied core-shell Ni@C foams.
**Fig. S3** MnO$_2$ formation depending on the mass ratio of KMnO$_4$ and NH$_4$OH. Substituted mass from carbon templates to MnO$_2$ coatings on Ni foams upon immersion in a KMnO$_4$ solution with different NH$_4$OH concentrations.

**Fig. S4.** EDS mapping of the three-times SGCW-applied core-shell Ni-MnO$_2$ foams. (a) SEM images of the core-shell Ni-MnO$_2$ foams and their (b) Mn, (c) O, (d) Ni, and (e) C elements. (f) Quantitative summary of the elemental composition.
Fig. S5 Electrochemical impedance spectroscopy (EIS) measurements in different volume ratios of KMnO$_4$ and NH$_4$OH. Nyquist plots of the core-shell Ni-MnO$_2$ foams fabricated by using a KMnO$_4$ solution with different NH$_4$OH concentrations.
Fig. S6 Electrochemical performance of the core-shell Ni-MnO$_2$ foams, fabricated by the direct attachment of MnO$_2$ without applying SGCWs, and with one- and two-times SGCWs. (a) Specific capacitances at various scan rates of 1, 2, 5, 10, 20, 50, 100, 200, and 500 mV/s. (b) EIS results. (c) Capacitance retention.
Fig. S7 Galvanostatic charge-discharge performance and capacitance retention of three-times SGCW-applied core-shell Ni@MnO$_2$ foams at a current density of 5 A/g.

Fig. S8 SEM image of the surface of the three-times SGCW-applied core-shell Ni@MnO$_2$ foams.
Fig. S9 Ragone plots of the specific energy and power density of supercapacitors using the three-times SGCW-applied core-shell Ni@MnO$_2$-based binder-free supercapacitor electrodes with different MnO$_2$-based electrodes.$^{1-4}$ The specific energy and power density of this work were obtained from the half-cell using the Ni@MnO$_2$-based binder-free supercapacitor electrode.
References


