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Supporting Information

3D Hierarchical $Ti_3C_2T_X$@$NiCo_2S_4$-RGO heterostructure hydrogel as free-standing electrodes for high-performance supercapacitors

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Figure S1 Electrochemical performance of the sample-1 of supercapacitor. (a) CV curves at different scan rates. (b) GCD curves at different current densities. (c) Specific capacities as a function of discharge current densities calculated from the GCD curves. (d) Ragone plot of the device. (e) Cycling stability at 10 A g^{-1} (inset shows the 1 rd and 10000 rd cycle GCD curves during the cycling test).

Figure S2 Electrochemical performance of the sample-2 of supercapacitor. (a) CV curves at different scan rates. (b) GCD curves at different current densities. (c) Specific capacities as a function of discharge current densities calculated from the GCD curves. (d) Ragone plot of the device. (e) Cycling stability at 10 A g^{-1} (inset shows the 1 rd and 10000 rd cycle GCD curves during the cycling test).

To ensure experimental reproducibility, we did corresponding experiments to research the electrochemical properties of multiple supercapacitor samples based on $Ti_3C_2T_X$@$NiCo_2S_4$-RGO hydrogel electrodes, and denote as sample-1 and sample-2, respectively. Figure. S1a displays the CV curves of the sample-1 at various scan rates. The reduction peak (at ca. 0.53 V) and oxidation peak (at ca. 0.34 V) exhibited a slight shift to the negative and positive directions with increasing sweep rate, and the shape of the CV curves remained almost unchanged with increasing scan rate, indicating the excellent reversibility of the sample-1. The same situation also occurs in sample-2 (Figure. S2a). GCD curves at various current densities in Figure. S1b display a curvature at similar voltages as the CVs, which originate from the pseudocapacitive nature of the electrodes. Moreover, the symmetric triangular shape with no clear IR drop of the GCD curves once again confirm the excellent capacitive behavior and electrochemical reversibility of the sample-1. The same situation occurs in sample-2 (Figure. S2b). Specific capacities as a function of discharge current densities calculated from the GCD curves, as shown in Figure. S1c and S2c. It can be seen that sample-1 show a decrease of the specific capacitance from 741.2 to 554.4 F g^{-1} as the current densities vary from 0.5 to 10 A g^{-1}, and the specific capacitance of sample-2 decreases from 720.2 to 533.8 F g^{-1}. It is noteworthy that the capacity retention of sample-1 was 74.8%, which is similar to that of sample-2 (74.1%). The E and P for the two samples are calculated from the GCD curves and plotted on the Ragone diagram as shown in Figure. S1d and S2d. The sample-1 shows an energy density of 74.77 Wh kg^{-1} at a power density of 308.1 W kg^{-1}, and the energy density keep at 43.71 Wh kg^{-1} at a high power density of 7121.7 W kg^{-1}. The sample-2 shows an energy density of 72.65 Wh kg^{-1} at a power density of 291.1 W kg^{-1}, and the energy density keep at 42.08 Wh kg^{-1} at a high power density of 7101.7 W kg^{-1}. Figure. S1e and S2e show the cycling stability of the two samples at 10 A g^{-1}, respectively. The retention was

approximately 98.4% for sample-1 over 10,000 charge/discharge process, which is similar to that of sample-2 (98.5%). Additionally, there is virtually no change of the GCD curves (inset to Figure. S1e and S2e), suggesting the superior cycling stability of the two samples. All the above experimental data are in good agreement with the corresponding test data of the device in the manuscript, which indicates that this study has good experimental reproducibility.