Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supplementary information

3D Printing-Based Cellular Microelectrodes for High-Performance Asymmetric Quasi-Solid-State Micro-Pseudocapacitors

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Calculation of Microelectrode and Device Capacitance and Energy Density Values

According to the obtained CV curves, the areal microelectrode (or device) capacitance values (C_a) of are calculated as follows:

$$C_a = \frac{\int idV}{2u \cdot \Delta V \cdot S} \tag{S1}$$

where i is the charge and discharge current values, u represents the scan rates, V represents the corresponding voltage values, ΔV and S are the corresponding voltage window and the total area, respectively.

The capacities (Q_a) of microelectrodes (or devices) were calculated by the following equation:

$$Q_a = C_a \cdot \Delta V \tag{S2}$$

where C_a is the corresponding capacitance, ΔV is the potential window.

According to the obtained device capacitance values (C_a), the device areal energy density values (E_a) are calculated as follows:

$$E_a = \frac{C_a \cdot (\Delta V)^2}{7200} \tag{S3}$$

where C_a and ΔV represent the device capacitance value and voltage window, respectively.

According to the obtained GCD curves, the areal microelectrode (or device) capacitance values (C_a) of are calculated as follows:

$$C_a = \frac{I \cdot \Delta t}{S \cdot \Delta V} \tag{S4}$$

where I represents the discharge current values, Δt is the discharge time, ΔV and S are the corresponding voltage window and the total area, respectively.

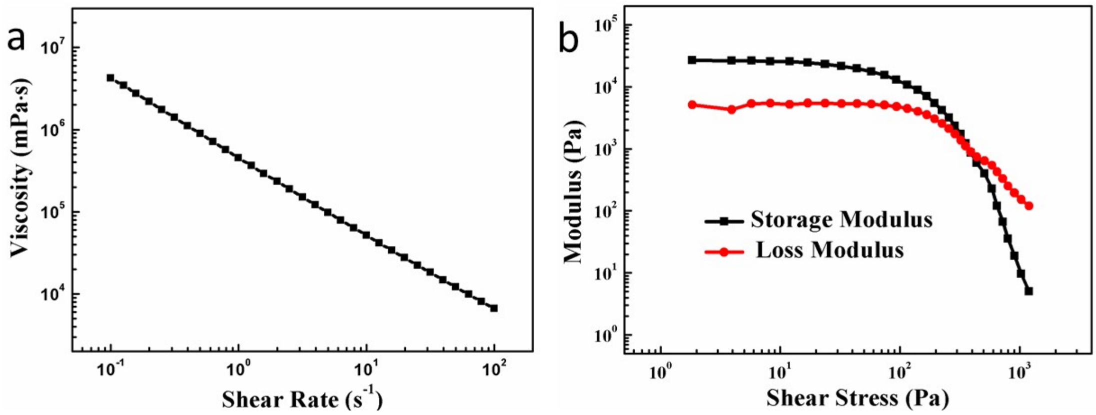

Fig. S1 (a) Apparent viscosities as a function of shear rate for GO ink. (b) Storage modulus and loss modulus values as a function of shear stress.[1]

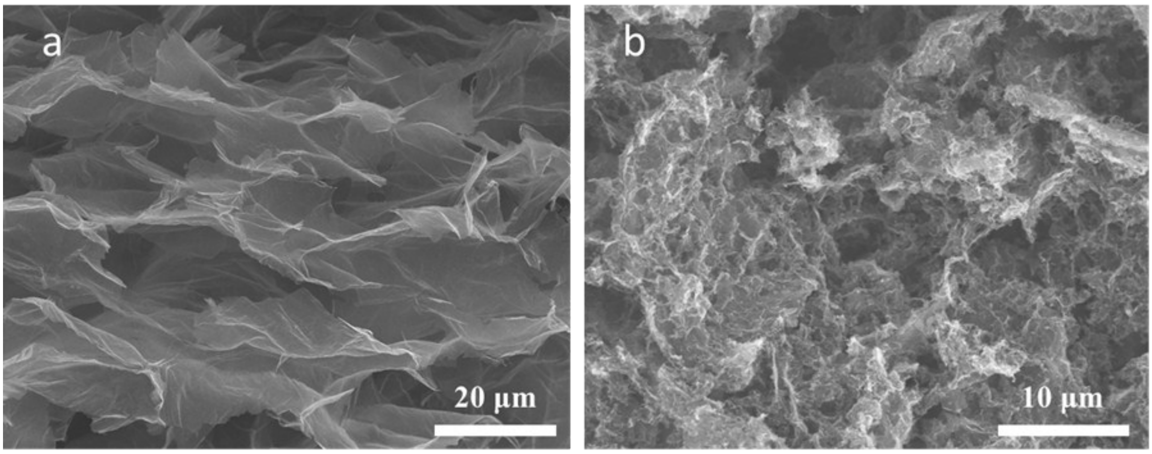

Fig. S2 SEM images of 3D-printed interdigitated (a) 3DG framework and (b) PG.

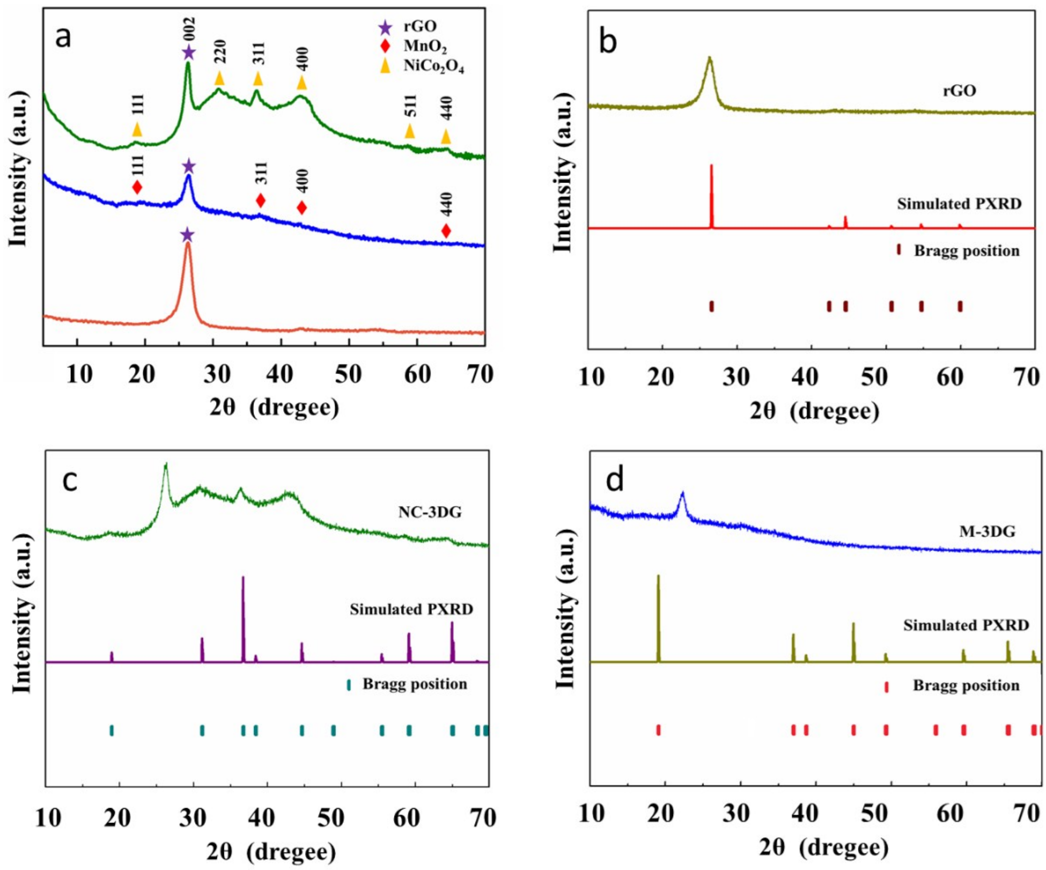

Fig. S3 (a) XRD patterns of fabricated samples and (b-d) simulated PXRD patterns for (b) rGO, (c) NC-3DG and (d) M-3DG.

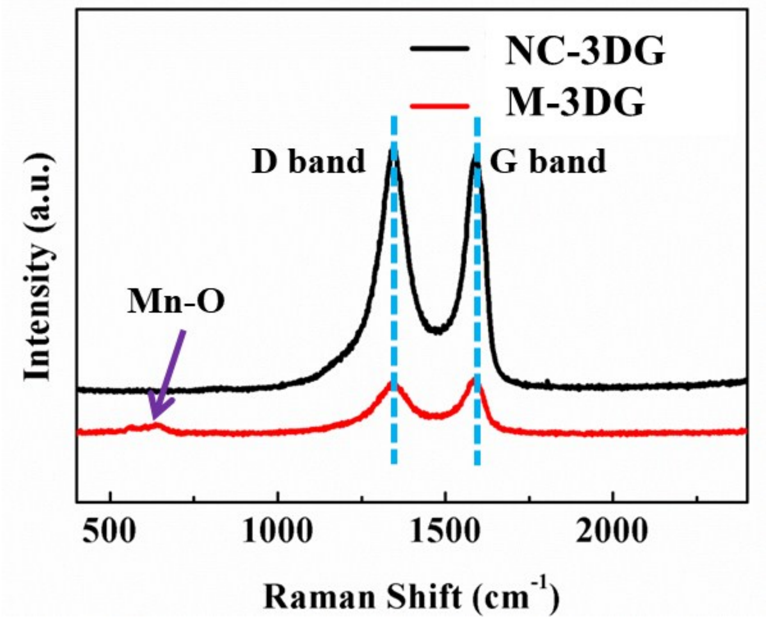

Fig. S4 Raman spectra of NC-3DG and M-3DG microelectrodes.

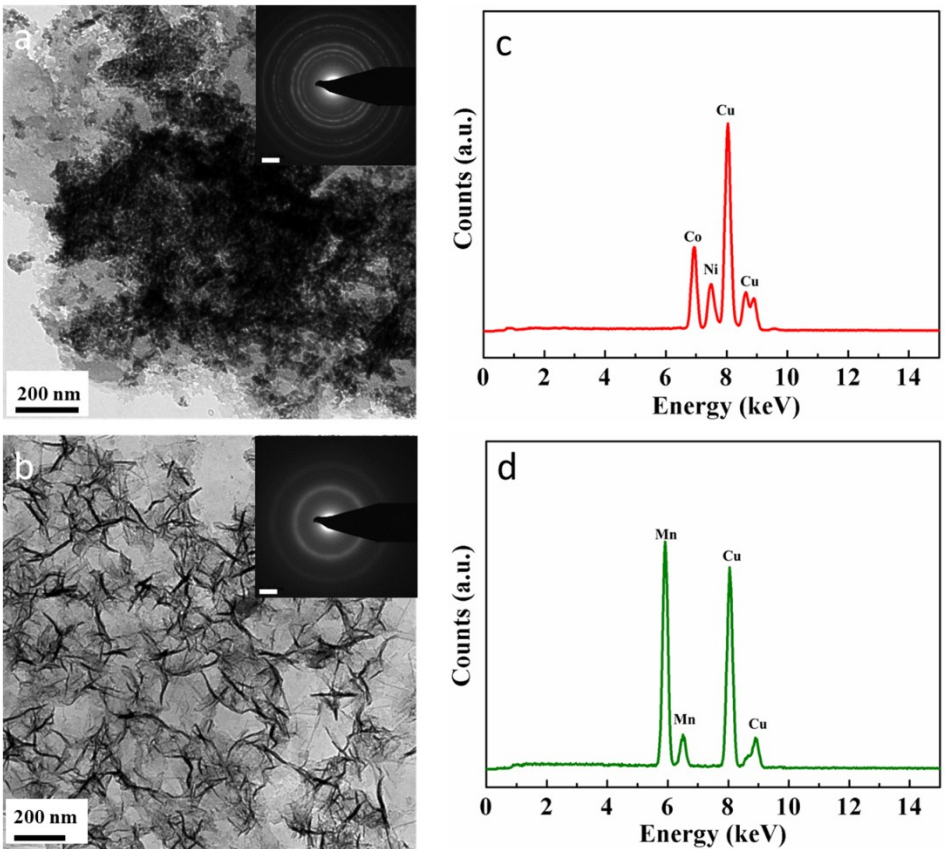

Fig. S5 TEM images of (a) NC-3DG and (b) M-3DG. The insets in (a,b) are corresponding SAED patterns (scale bar: 2 1/nm). (c,d) EDS spectra of (c) NC-3DG and (d) M-3DG obtained from the sample shown in (a) and (b), respectively.

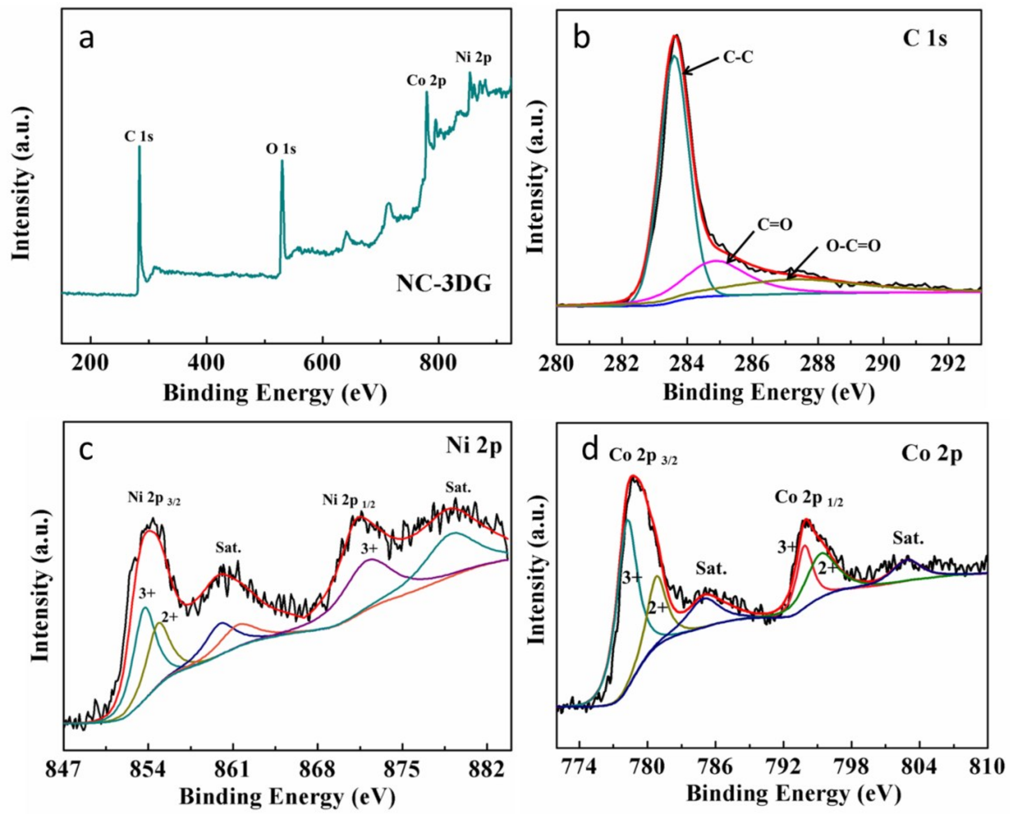

Fig. S6 (a) XPS survey spectrum of NC-3DG. (b) C 1s, (c) Ni 2p and (d) Co 2p XPS spectra on NC-3DG.

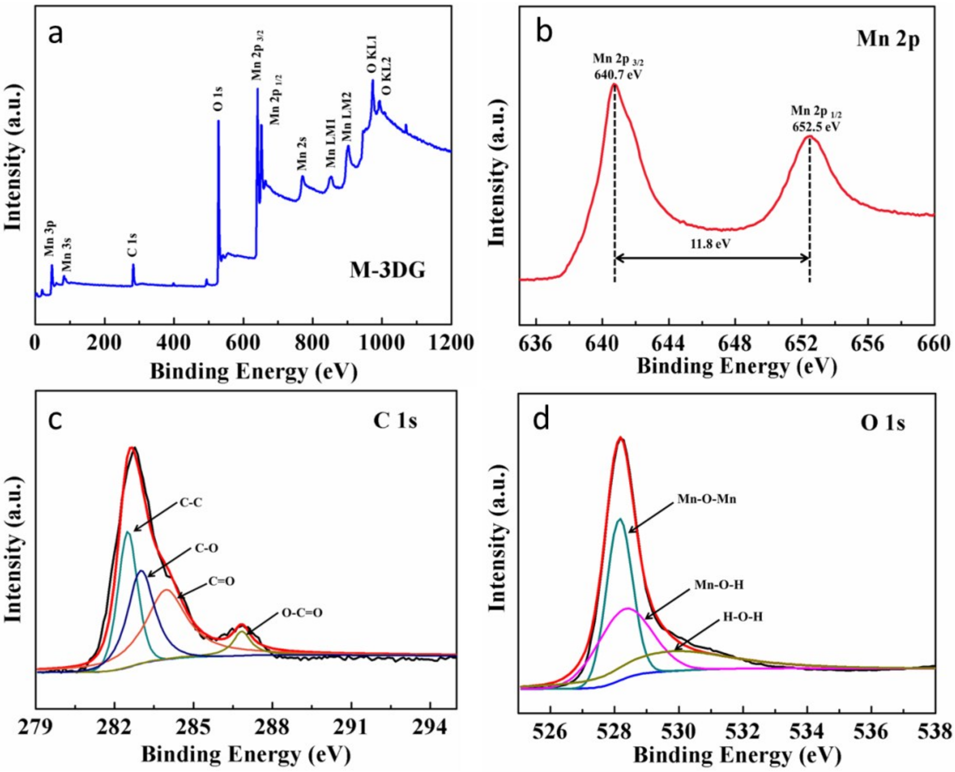

Fig. S7 (a) XPS survey spectrum of M-3DG. (b) Mn 2p, (c) C 1s and (d) O 1s XPS spectra on M-3DG.

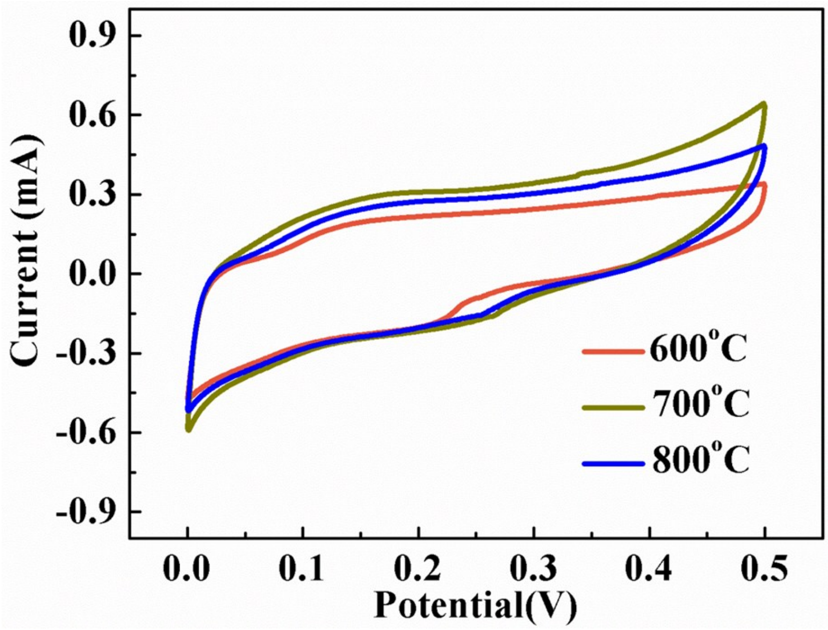

Fig. S8 CV curves at a scan rate of 50 mV s^{-1} for 3DG obtained at different reduction temperatures.

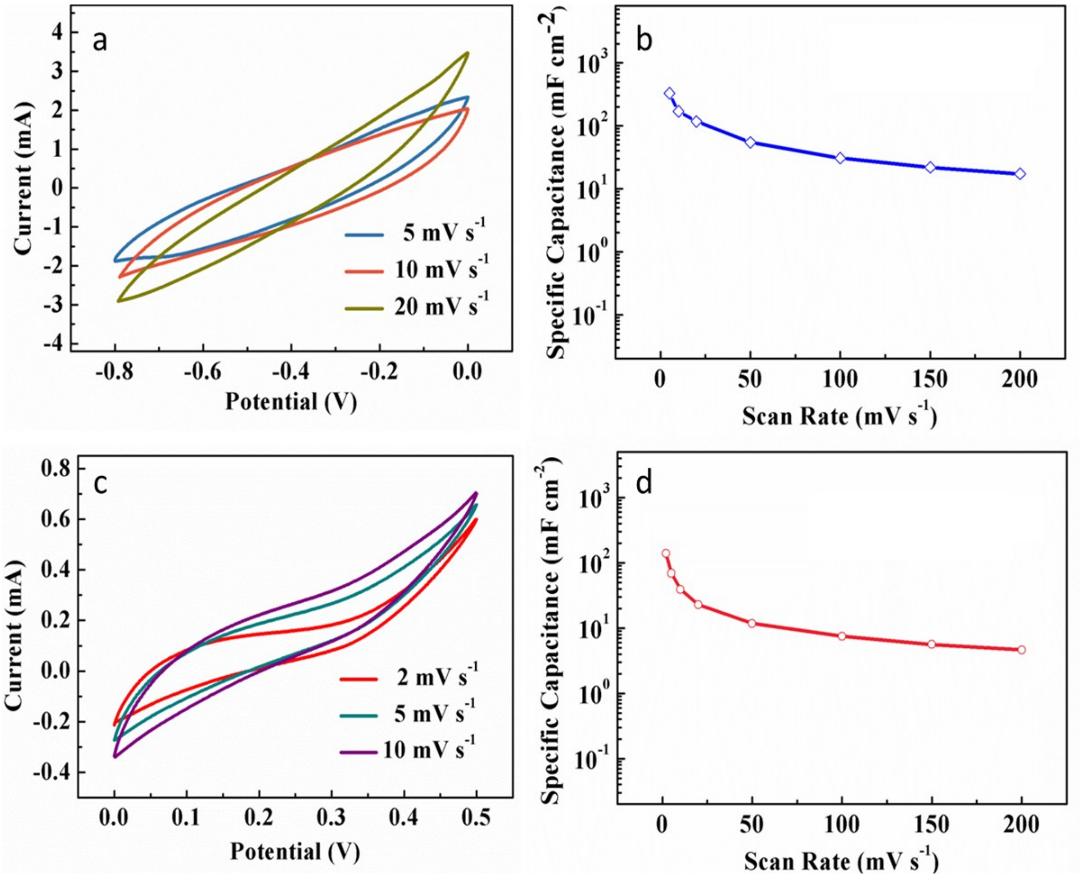

Fig. S9 CV curves of and corresponding capacitance values of (a,b) NC-3DG(2) and (c,d) M-3DG microelectrodes.

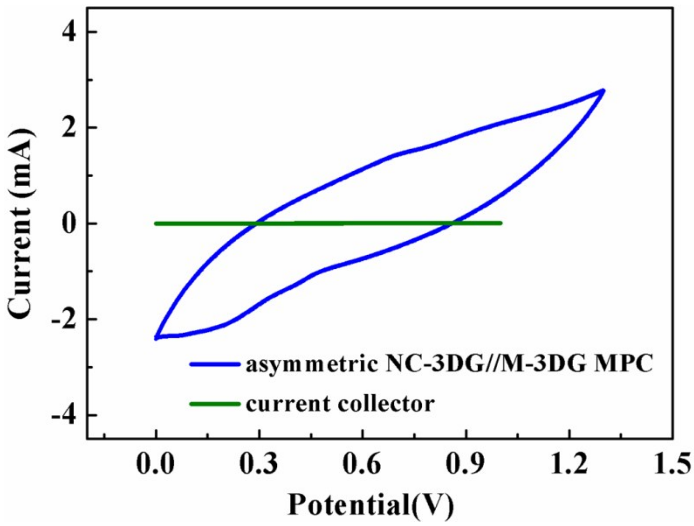

Fig. S10 CV curves at a scan rate of 10 mV s^{-1} for asymmetric NC-3DG//M-3DG MPC and current collector.

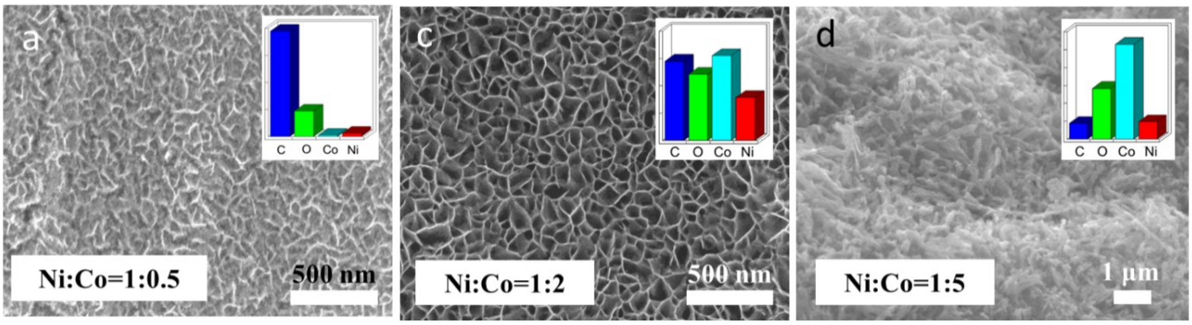

Fig. S11 (a-c) SEM images of NC-3DG microelectrodes with different Ni/Co mole ratios.

Table S1 A review of capacitive performance of reported MSCs.

Device Electrodes	Specific capacity (rate)	Electrolyte	Ref.
3D-printing-stamped $Ti_3C_2T_x$	37 mC cm^{-2} (0.025 mA cm^{-2})	H_2SO_4/PVA	2
3D-printed rGO	74 mC cm^{-2} (5 mV s^{-1})	H_2SO_4/PVA	3
3D-printed GO/PANI	123 mC cm^{-2} (5 mV s^{-1})	H_3PO_4/PVA	4
VO_x/rGO//G–VNQDs/rGO	333 mC cm^{-2} (0.63mA cm^{-2})	LiCl/PVA	5
NC-3DG//M-3DG	**500 mC cm^{-2} (2 mV s^{-1})**	**KOH/PVA**	**This work**

References

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