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SUPPLEMENTARY INFORMATION

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The Right Kind of Interior for Multifunctional Electrode Architectures: Carbon Nanofoam Papers with Aperiodic Submicrometer Pore Networks Interconnected in 3D

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Supplementary Information



25 Fig. S1 X-ray photoelectron spectroscopy of Lydall carbon fiber paper before and after treatment (A) in an air/ice plasma in 2010 showing the highresolution data for the O *1s* regions (see Fig. 2 for the C *1s* region) and (B) in either an air/ice plasma or air plasma in 2008.



Fig. S2 Scanning electron microscopy images of Lydall carbon fiber paper before (top row) and after (bottom row) treatment in a radio-frequency glow ¹⁰ discharge plasma with an ice/air atmosphere.



Fig. S3 Photographs of (A) a sandwiched assembly of carbon fiber paper between glass microscope slides; (B) gradually sweeping the meniscus of RF ⁵⁰ solution across the fiber paper; (C) applying pressure to the glass slides with binder clips; (D) sealing the reaction assembly in duct tape; and (E) the aluminum pouch that contains the reaction assembly for processing within a pressure cooker.

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Fig. S4 Low magnification scanning electron micrograph of the exterior 5 surface of a 40 wt % RF(1300 R/C) nanofoam paper showing micrometer-sized cracks at the surface, which do not propagate through the thickness of the paper.

ry scale-up: 10 cm × 10 cm

Fig. S5 Scalability of device-ready carbon nanofoam electrodes is readily achieved simply by increasing the geometric area of the paper that serves as the molding form for the RF sol to $10 \text{ cm} \times 10 \text{ cm}$.



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Fig. S6 Specific capacitance for (A) one-ply and (B) two-ply 40 wt% RF(1500*R/C*) as measured in a nonaqueous electrolyte of 0.1 M tetrabutylammonium perchlorate in acetonitrile. The average capacitance was calculated by averaging the current from 300 to 700 mV and then dividing 25 by the scan rate. The average specific capacitance was calculated by dividing the average capacitance by the mass of the carbon nanofoam. The electrochemical surface area was calculated from the following equation:

Electrochemical surface area (m² g⁻¹) = Specific capacitance (F g⁻¹) $\times \frac{\text{cm}^2}{10^{-5}\text{F}} \times \frac{(1 \text{ m})^2}{(100 \text{ cm})^2}$

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Table S1 Porosimetry data from N₂-sorption isotherms of RF carbon nanofoam papers and aerogel-like monoliths.

Sample ^a	BET surface area (m ² g ^{−1})	Micropore area (m ² g ⁻¹) ^c	Micropore volume (cm ³ g ⁻¹) ^c	BJH cumulative pore volume; adsorption (cm ³ g ⁻¹) ^d	BJH pore size; adsorption (nm)
40 1500 NF ^b	332	395	0.13	0.26 ^e	13
Aerogel ^b	648	481	0.23	1.62	31
Ambigel ^b	600	422	0.20	1.39	30
50 1500 NF	486	297	0.14	0.94	16
50 500 NF	533	263	0.12	0.79	10

^{*a*} First number corresponds to weight percentage of RF, the second to the molar ratio of resorcinol to catalyst (R/C).

^b Materials derived from same batch of 40 wt % RF(1500 R/C) sol; all sol-filled forms were steam processed together to form the polymeric gels.

^{*c*} Estimated using the *t*-plot method.

^d Determined for pores between 1 and 300 nm in width.

^e Because of the large pores in this formulation, the BJH model underestimates the total pore volume and pore size.



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Fig. S7 Pore size distribution derived from nitrogen porosimetry obtained on three RF polymer-derived carbon nanofoams and gels formed from the same RF formulation, 40 wt % RF(1500 *R/C*), and sol-gel processing: aerogel (•••••); ambigel (—); and carbon-fiber-paper-supported carbon nanofoam (- - -). Data were fitted with Micromeritics DFT Plus® software, using a density functional theory (DFT) model for a cylindrical geometry and Halsey 15 curve thickness.

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15 Notes and references

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