Supplementary Information

Battery-Like Supercapacitors from Diamond Networks and Water-Soluble Redox Electrolytes

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Table S1. Capacitance comparison of diamond nanostructures based electric double layer capacitors (EDLCs) and pseudocapacitors (PCs).

Type	**Capacitor Electrode**	**Capacitance [mF cm^{-2}]**	**Electrolyte**	**Ref.**
EDLC	Diamond	$(4-7)\times10^{-3}$	Na_2SO_4	1
	Diamond network	3.53	Na_2SO_4	This work
	Diamond/Silicon nanowires	0.1	PMPyrrTFSI + propylene carbonate	2
		1.5	Et_3NH TFSI	3
	Diamond foam	0.60	$NaClO_4$	4
		0.44	PMPyrrTFSI + propylene carbonate	4
	Honeycomb diamond	1.97	H_2SO_4	5
		3.91	H_2SO_4	6
		0.67	$TEABF_4$ + propylene carbonate	7
	Porous diamond	3	$LiClO_4$	8
	BDD/TiO_2	7.46	$NaNO_3$	9-11
	$TiO_2/BDD/Ta$	5.23	Na_2SO_4	12
	BDD/Nanotube	0.58	PBS	13
PC	Diamond	41.51	$Na_2SO_4 + Fe(CN)_6^{3-/4-}$	This work
	Diamond network	73.42	$Na_2SO_4 + Fe(CN)_6^{3-/4-}$	This work
	MnO_2/Diamond	7.82	Na_2SO_4	1
	$Ni(OH)_2$/Diamond Nanowire	91	NaOH	14

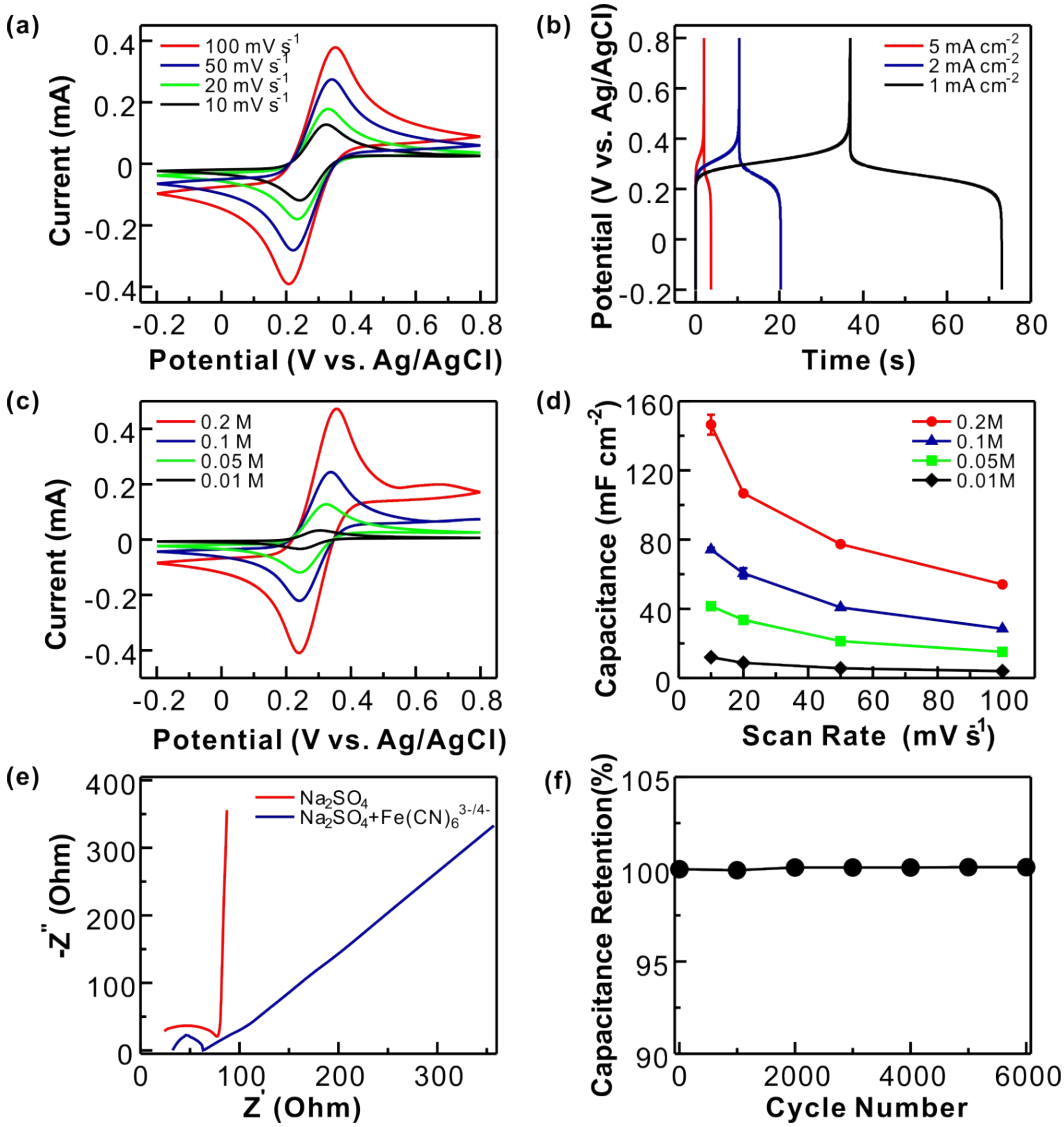

Figure S1. Performance of a diamond PC using $Fe(CN)_6^{3-/4-}$ redox electrolytes. (a) Cyclic voltammograms of 0.05 M $Fe(CN)_6^{3-/4-}$ in 1.0 M Na_2SO_4 at the scan rates of 10, 20, 50, and 100 mV s^{-1}. (b) Charge/discharge curves of 0.05 M $Fe(CN)_6^{3-/4-}$ in 1.0 M Na_2SO_4 at the current densities of 1.0, 2.0, and 5.0 mA cm^{-2}. (c) Cyclic voltammograms of $Fe(CN)_6^{3-/4-}$ with the concentrations of 0.01, 0.05, 0.1, and 0.2 M in 1.0 M Na_2SO_4 at the scan rate of 10 mV s^{-1}. (d) Capacitance comparison calculated from cyclic voltammogramms at different scan rates and different concentrations of $Fe(CN)_6^{3-/4-}$. (e) Nyquist plots in the frequency range of 10^6 - 0.01 Hz with and without 0.05 M $Fe(CN)_6^{3-/4-}$ in 1.0 M Na_2SO_4 as the electrolyte. (f) Capacitance retention at a charge/discharge current density of 5 mA cm^{-2} in 0.05 M $Fe(CN)_6^{3-/4-}$ + 1.0 M Na_2SO_4 .

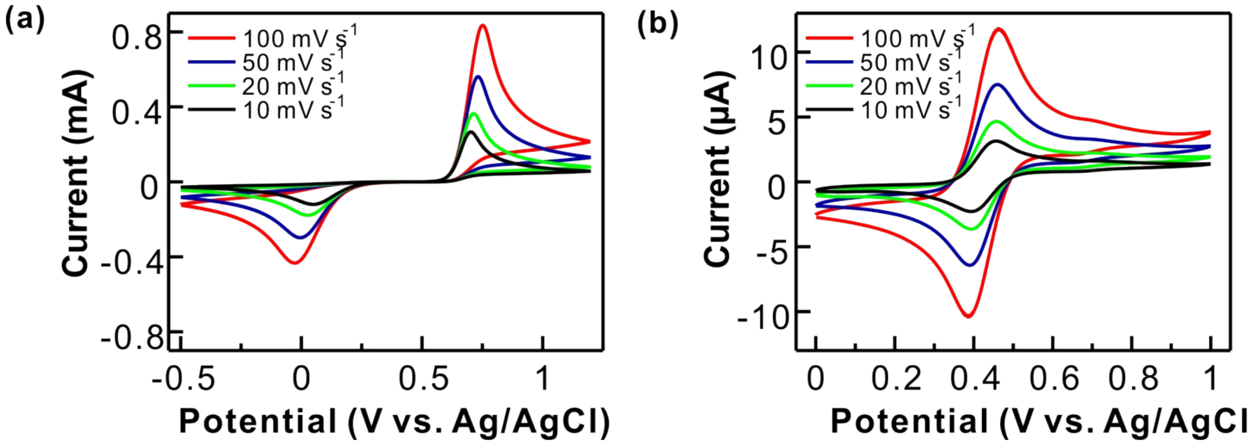

Figure S2. Performance of a diamond PC using other water-soluble redox electrolytes. (a) Cyclic voltammograms of 0.1 M hydroquinone in 1.0 M H_2SO_4. (b) Cyclic voltammograms of 2 mM $FcTMAPF_6$ in 0.1 KCl. The scan rates were 10, 20, 50, and 100 mV s^{-1}.

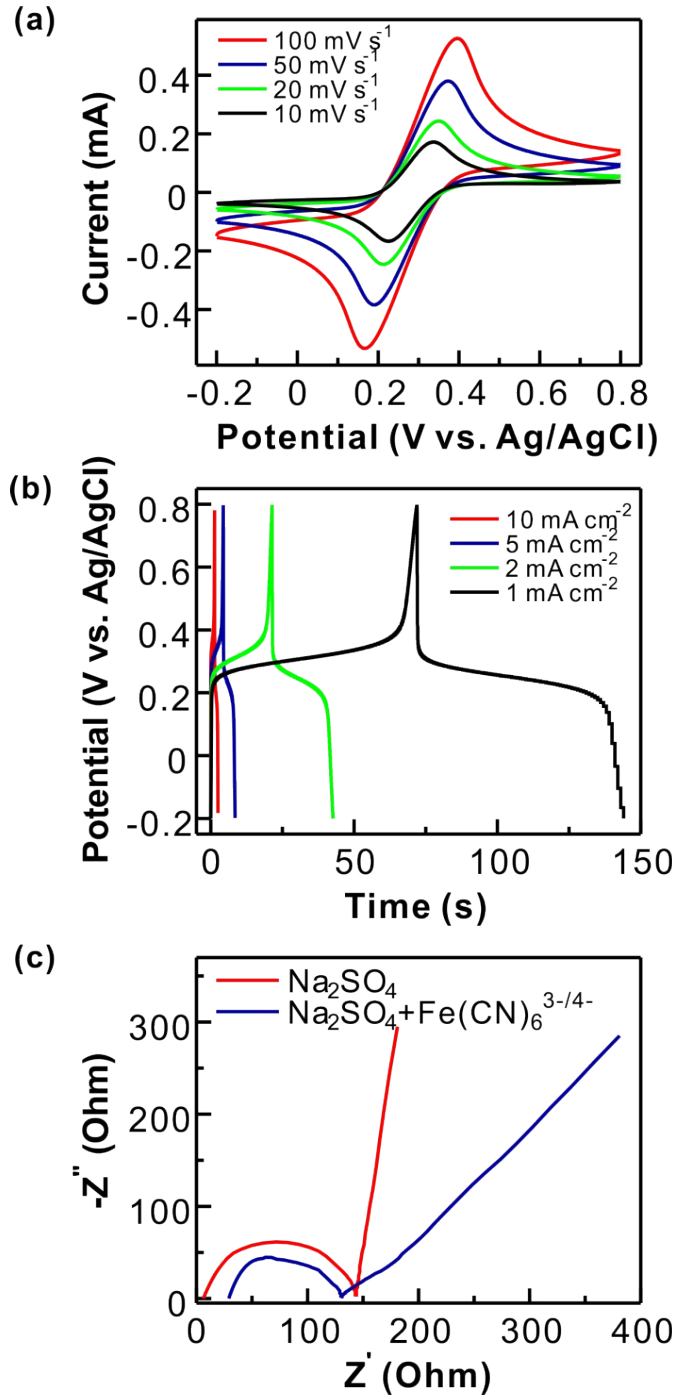

Figure S3. Performance of a diamond network PC using water-soluble redox electrolytes. (a) Cyclic voltammograms of 0.05 M $Fe(CN)_6^{3-/4-}$ in 1.0 M Na_2SO_4 at the scan rates of 10, 20, 50, and 100 mV s^{-1}. (b) Charge/discharge curves of 0.05 M $Fe(CN)_6^{3-/4-}$ in 1.0 M Na_2SO_4 at current densities of 1.0, 2.0, and 5.0 mA cm^{-2}. (c) Nyquist plots in the frequency range of 10^6 - 0.01 Hz with and without 0.05 M $Fe(CN)_6^{3-/4-}$ in 1.0 M Na_2SO_4 as the electrolyte.

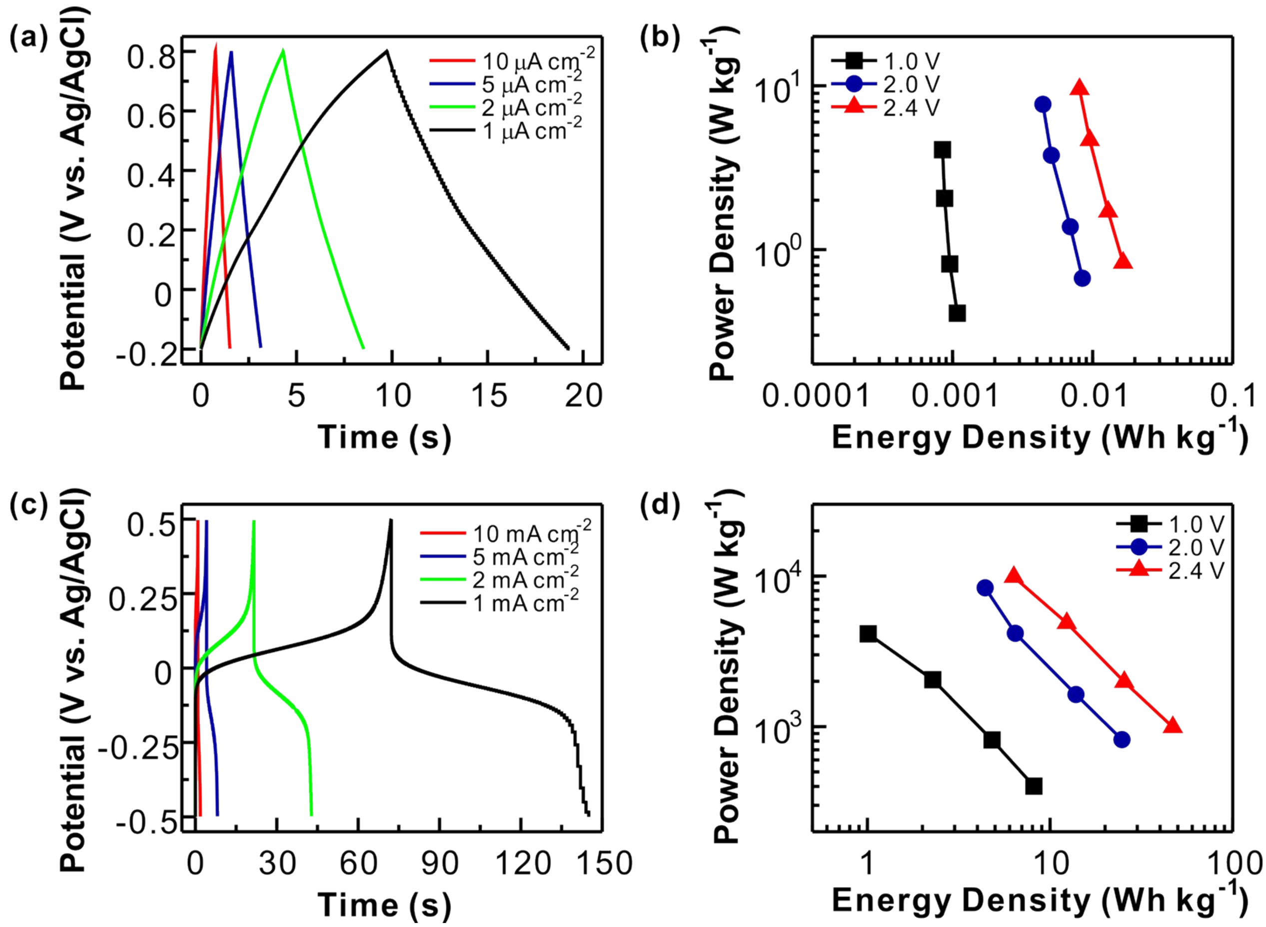

Figure S4. Performance of diamond symmetric EDLC and PC devices. (a) Charge/discharge curves of a diamond EDLC device in 1.0 M Na_2SO_4 at the current density of 1.0, 2.0, 5.0 and 10.0 μA cm^{-2}. (b) Ragone plots of a diamond EDLC device in 1.0 M Na_2SO_4 with a cell voltage of 1.0, 2.0 and 2.4 V. (c) Charge/discharge curves of a diamond PC device in 0.05 M $Fe(CN)_6^{3-/4-}$ + 1.0 M Na_2SO_4 at the current density of 1.0, 2.0, 5.0 and 10.0 mA cm^{-2}. (d) Ragone plots of a diamond PC device in 0.05 M $Fe(CN)_6^{3-/4-}$ + 1.0 M Na_2SO_4 with a cell voltage of 1.0, 2.0 and 2.4 V.

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