Electronic Supplementary Information (ESI)

for *RSC Advances*

Ultrahigh-performance Nonaqueous Electric Double Layer Capacitors Using an Activated Carbon Composite Electrode with Alginate

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1. Experimental

Synthesis: An activated carbon composite electrode for a test cell was made by the following process. A mixture containing the activated carbon, commercially produced by Kuraray Chemical Co., and acetylene black (AB) as a conductive additive was added to an 3 wt% aqueous solution of sodium alginate (KIMICA ALGIN®, KIMICA Corporation). The solution was then casted onto an aluminum current collector. After drying on a hot plate the composite electrode was obtained by drying under vacuum at 80 °C for 24 h. The composition of the electrode was 85 wt% activated carbon, 5 wt% AB, and 10 wt% Alg. Composite electrodes with battery-grade sodium carboxymethy cellulose (CMC, Cellogen®, Dai-ichi Kogyo Seiyaku Co., Ltd.) and poly(vinylidenfluoride) (PVdF, Kureha Co.) were also prepared for comparison. All electrodes were fabricated with a diameter of 12 mm, and their active layer thicknesses were 90 μm.

Measurements: We constructed a two-electrode symmetric model cell for electrochemical measurements. Prior to assembling the model cell, a pair of electrodes were immersed in an electrolyte (1.8 mol dm^{-3} $TEMABF_4$/PC or $EMImBF_4$) for 2 h under reduced pressure. The model cell was fabricated with the pair of electrodes and the poly(propylene)-based separator containing the electrolyte. All components were mounted in a stainless steel container as the cell exterior. The performance of the EDLC test cells were measured by a computerized battery charge/discharge analyzer (HJ-SM8, Hokuto Denko Co.) Charge–discharge tests were carried out in a cell voltage range between 0 and 2.5 V at several current densities. Charge–discharge cycling was measured at 10 A g^{-2} (10,000 cycles). Several AC impedance measurements were run on the cells using a Solartron Analytical SI-128787A connected to an impedance/gain-phase analyzer (SI-1260, Solartron Analytical) with applied AC amplitude of 10 mV and a frequency range of 500 kHz to 10 mHz to evaluate the electrode–electrolyte interface. All electrochemical measurements were performed at room temperature (25 ± 2 °C).

2. Additional Results

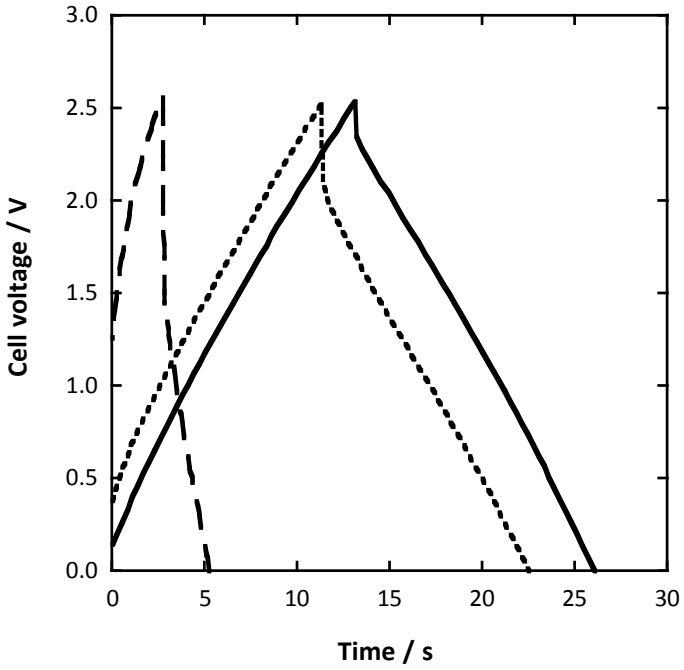

Figure S1. Charge–discharge curves of the test cells with composite electrodes prepared using Alg (—), CMC (·····), and PVdF (- - -) as a binder at a current density of 10 A g^{-1}. The maximum cell voltage is 2.5 V.

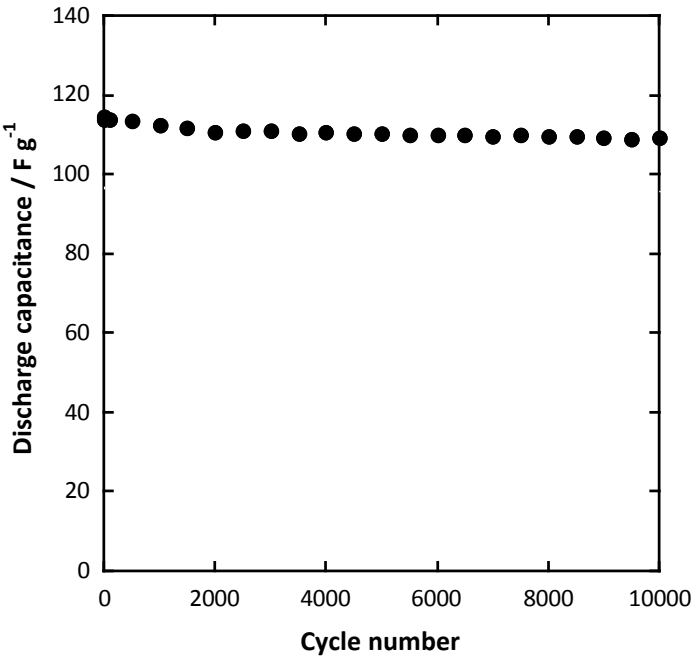

Figure S2. Cyclabilities of test cells for Alg binder. Charge–discharge measurements were conducted at a constant current density of 10 A g^{-1} in a cell voltage range from 0 to 2.5 V.

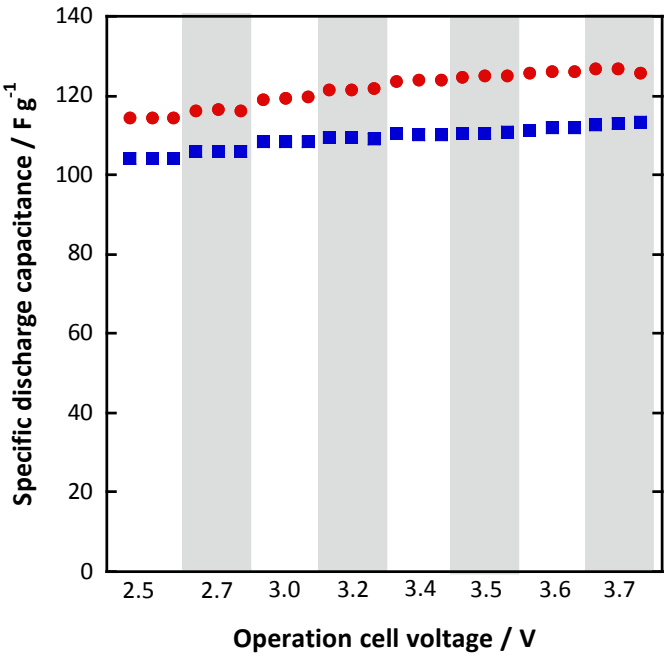

Figure S3. Operation voltage dependence of discharge capacitance of the cells for the Alg (●) and CMC(■)binders, obtained at 10 A g^{-1} in the operation voltage range from 2.5–3.7 V. TEMABF$_4$/PC is employed as the electrolyte.