Supporting Information

In-Situ-Activated N-Doped Mesoporous Carbon from a Protic Salt and Its Performance in Supercapacitors

*Tiago C. Mendes,[†] Changlong Xiao,[†] Fengling Zhou,[†] Haitao Li,[†] Gregory. P. Knowles,[†] Matthias Hilder,[‡] Anthony Somers,[‡] Patrick C. Howlett,[‡] and Douglas. R. MacFarlane, *[,†]*

[†]School of Chemistry, Monash University, 3800 Melbourne, Victoria Australia

[‡]ARC Centre of Excellence for Electromaterials Science (ACES), Institute for Frontier Materials (IFM), Deakin University, Burwood, Victoria 3125, Australia

Corresponding author:

*(D. R. M) Email: douglas.macfarlane@monash.edu. Telephone: +61 3 9905 4540

EXPERIMENTAL SECTION

(i) Protic salt synthesis

[BIm][TfO] was synthesized by a stoichiometric neutralization between the amine benzimidazole and triflic acid in aqueous/organic solvent. Typically, 10.0 g of benzimidazole (>98%) was dissolved in 60 mL of ethanol and was slowly dropped into diluted triflic acid (12.6 g, 99%, 60 mL water) in a three neck round bottom flask kept in an ice bath. After the complete addition of amine, the mixture was kept stirring for 2 hours. Afterwards, the solvent was removed by using a rotary evaporator and the solid was subsequently dried at 65°C under vacuum for 24 hours.

(ii) Electrode preparation

Electrodes were prepared by using a carbon slurry composed of 75% of active material (NDMC's), 15% of poly(vinylidene) fluoride (PVDF, Aldrich) and 10% of carbon black (Vulcan XC-72R). The slurry was obtained by carefully mixing the materials in a mortar with N-methyl-2-pyrrolidone (Aldrich) until a homogeneous paste was formed. Subsequently the carbon slurry was coated onto aluminium foil (current collector) with the aid of a drawdown coating rod. The film obtained was dried at 110°C for 12h and then punched into disks of 1.11 cm (7/16 inches) and left for drying under vacuum at 70°C for 12 hours, the mass loading of a single electrode was controlled to be 0.30 $mg.cm^{-2}$.

(iii) Electrochemical measurements in a 3-electrode setup

The electrochemical cell was assembled inside the glovebox where NDMC-10 electrodes (0.26 cm^2) were applied as working electrode, platinum wire as counter and Ag/Ag^+ as reference electrode. The reference electrode was prepared by using an internal reference solution of 10 mM of silver triflate dissolved in the actual electrolyte (1M $TEABF_4$/AN or $EMIMBF_4$) and in direct contact with a silver wire; this internal solution was separated from the main electrolyte through a porous frit. Capacitance measurements were obtained via cyclic voltammetry technique and the potential was swept between -1.7 V and 1.0 V vs. Ag/Ag^+ using different scan rates at 20 mV/s, 50 mV/s and 100 mV/s; the specific capacitance was calculated by integrating the cathodic current according to Equation S1:

$$C_{sp} = \frac{1}{mv(V_b - V_a)} \int_{V_a}^{V_b} I dV \qquad \text{(S1)}$$

where I is the instantaneous cathodic current (A), V_a and V_b are the limiting potentials (V), m is the mass of the carbon active material (g) and v is the scan rate (V/s).

SUPPORTING FIGURES

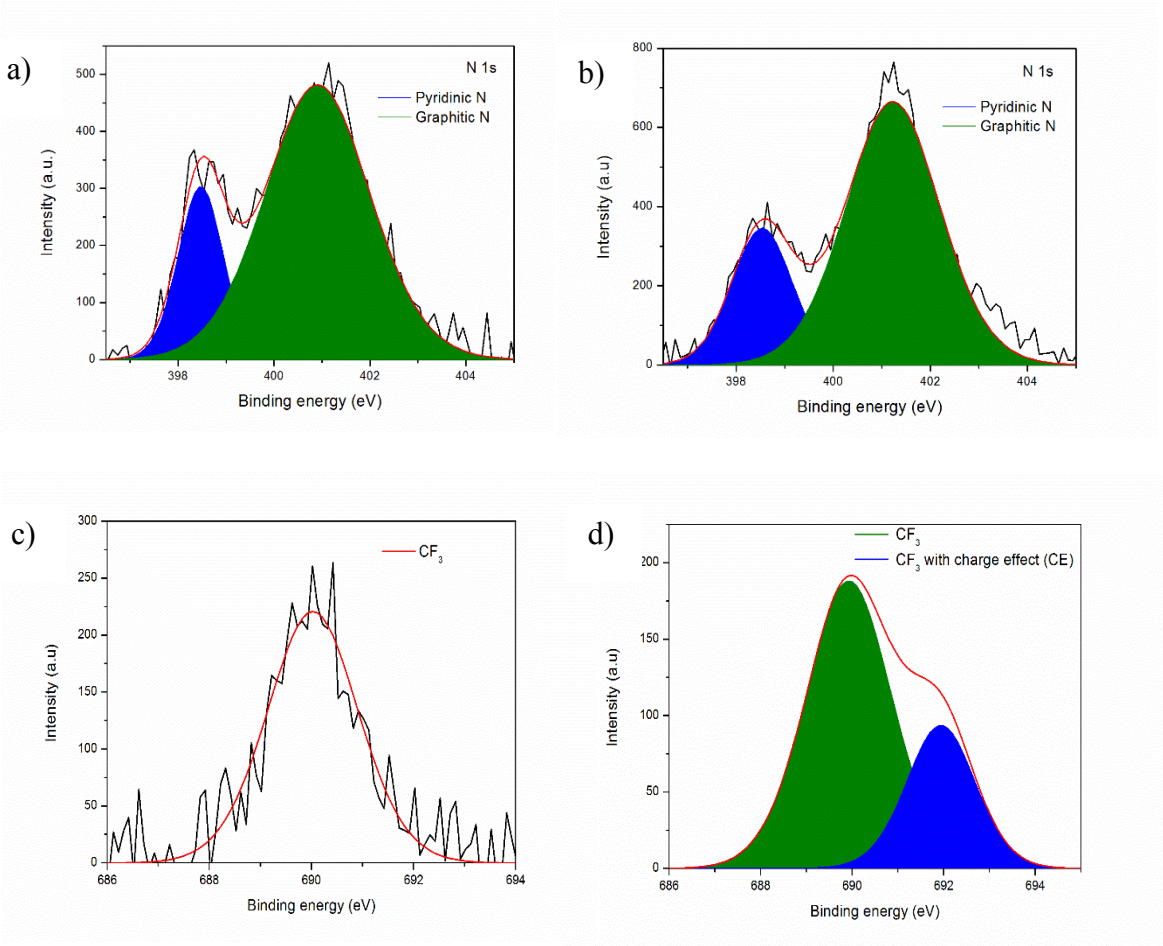

Figure S1. XPS N-High resolution scans: (a) NDMC-4 and (b) NDMC-8; F-High resolution scans: (c) NDMC-8 and (d) NDMC-10.

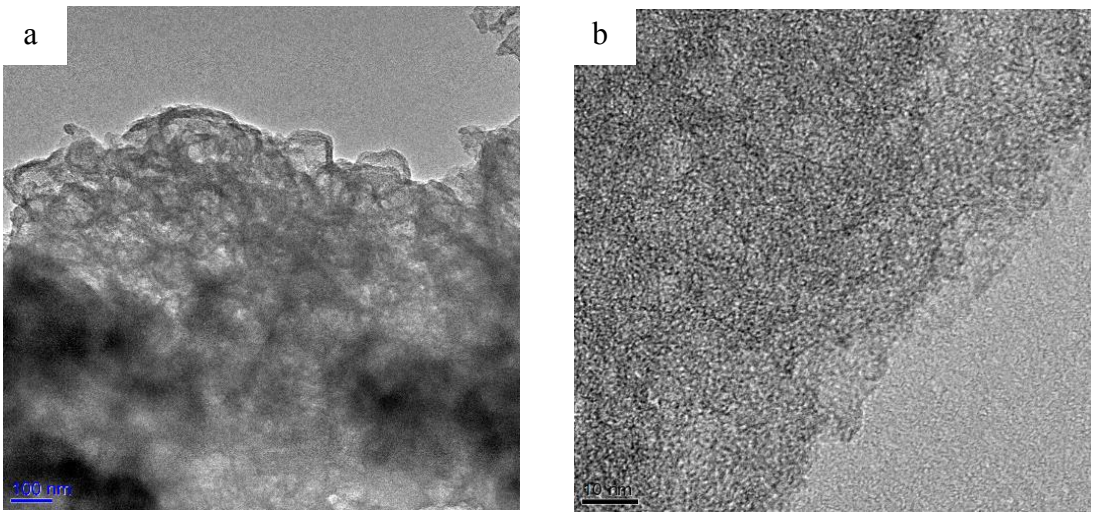

Figure S2. TEM micrographs of NDMC-10: (a) low and (b) high resolution.

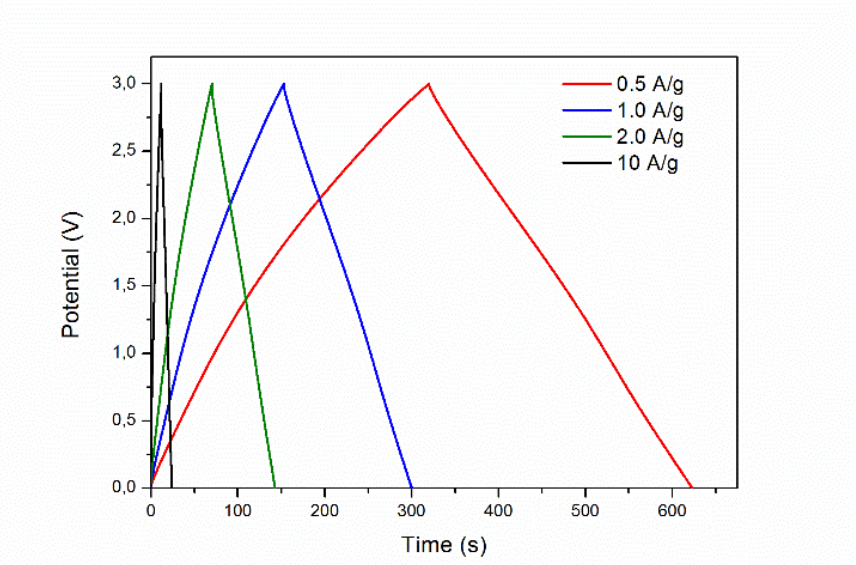

Figure S3. Galvanostatic charge-discharge at different current densities using NDMC-10 with $EMIMBF_4$ as electrolyte.

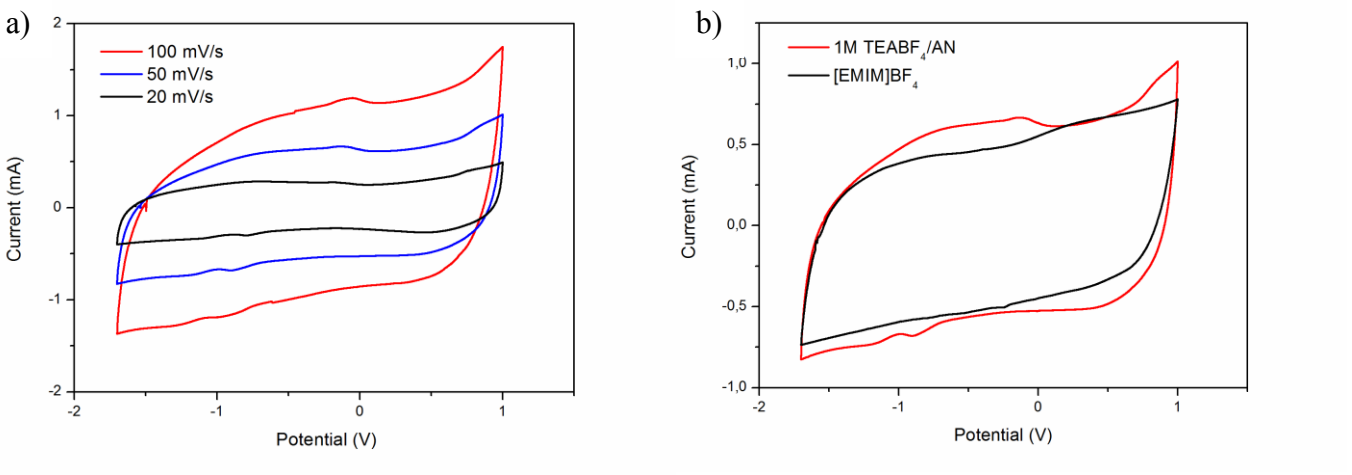

Figure S4. Electrochemical measurements of NDMC-10 in a 3-electrode cell: (a) Cyclic voltammetry of NDMC-10 in organic electrolyte at different scan rates (b) Cyclic voltammetry of both organic and ionic liquid electrolytes at 50 mV/s.

For the cyclic voltammograms obtained in Figure S4a (organic electrolyte), calculated specific capacitances as high as 201 F/g, 198 F/g and 169 F/g were achieved using scan rates at 20, 50 and 100 $mV.s^{-1}$, respectively; as is often observed, the single electrode measurements present larger capacitance than are achieved in symmetrical coin cell devices.[1-2] The comparison between organic and ionic liquid electrolytes is also provided in Figure S4b; as we can see, the specific capacitance of [EMIM][BF_4] is relatively close to the organic electrolyte, reaching a value of 170 F/g at 50 mV/s. The capacitance response of NDMC-10 in a three-electrode arrangement showed to be higher in organic electrolytes than in ionic liquid, such behavior agrees well with our studies in symmetric supercapacitors.

REFERENCES

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