Electronic Supplementary Information

TransCap: a monolithically integrated supercapacitor and electrolyte-gated transistor

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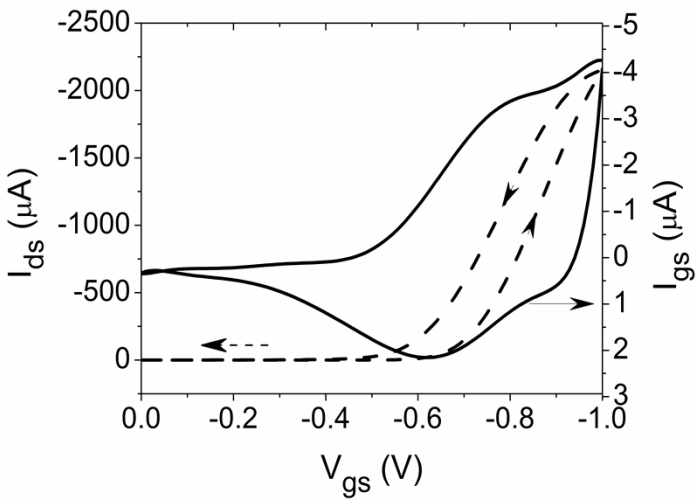

Fig. S1. Transfer characteristics of the $[N_{1113}][TFSI]$-gated MEH-PPV TransCap at saturation (V_{ds}= -300 mV) with V_{gs} at 10 mVs^{-1}. I_{ds} on the left axis, dashed line, I_{gs} on the right axis, solid line.

Materials: MEH-PPV Thin film deposition

Substrates were cleaned by sequential ultrasonic baths in isopropyl alcohol (IPA, J. T. Baker, microelectronic grade, 5 min), acetone (J. T. Baker, microelectronic grade, 10 min), and IPA (5 min), followed by a 5 min dehydration process at 120 °C in N_2 atmosphere consisting of 3 purging cycles of low pressure (20 Torr) and high pressure (500 Torr). Drain and source contacts of Ti/Au, 5/40 nm/nm, were photolithographically patterned on SiO_2 substrates (channel width, W, 4000 μm and length, L, 10 μm). 5 mg of MEH-PPV (Sigma Aldrich, 55 kDa) in 1 mL of toluene (anhydrous, Sigma Aldrich) were mixed and stirred overnight in a N_2 glove box (O_2, H_2O lower than 5 ppm) keeping the temperature at about 40 °C. MEH-PPV thin films were deposited by spin coating the solution at 1000 rpm. Afterwards, films were thermally treated at 70 °C for 3 hours. The final MEH-PPV thickness was 50 nm and the polymer mass loading was ca 5 $\mu g \cdot cm^{-2}$, considering a polymer density of ca 1 g/cm^3.[1]

1. H. Hoppe et al,*Thin Solid Films*, 511-512 (2006) 587-592

Materials: Ionic Liquid

$[N_{1113}][TFSI]$ (Solvionic, 99.5%) was used as received. At room temperature the ionic liquid features an electrochemical stability window of 5.7 V and an ionic conductivity of 3.3 $mS \cdot cm^{-1}$.[2]

2. M. Lazzari, C. Arbizzani, F. Soavi and M. Mastragostino, Ch. 9 in *Supercapacitors: Materials, Systems and Applications* (F. Béguin and E. Frackowiak Eds, Wiley-VCH, 2013), pp. 289–306.

Device fabrication

The device fabrication was carried out by sandwiching a Durapore® GVHP filter separator (9 mm × 4 mm × 125 μm) soaked in the ionic liquid between the MEH-PPV thin film and the activated carbon gate electrode. The gate electrode was prepared using carbon paper (Spectracarb 2050, 3 mm × 6 mm) coated with 6 μL of an ink of activated carbon (PICACTIF SUPERCAP BP10, Pica, BET specific surface area 1850 m^2g^{-1}, 28 $mg \cdot mL^{-1}$) and polyvinylidene fluoride (PVDF, KYNAR HSV900, 1.4 $mg \cdot mL^{-1}$) binder in N-methyl pyrrolidone (NMP, Fluka, >99.0%) solvent. The coating was followed by a thermal treatment at 60 °C for several hours to remove solvent and water traces. The activated carbon mass loading was ca. 0.9 $mg \cdot cm^{-2}$. The footprint of the TransCap corresponds to the geometric area of the separator (0.36 cm^2).

TransCap electrochemical and electrical characterization

The electrical and electrochemical characterizations of the TransCap were carried out in a N_2 glove box (H_2O, O_2 lower than 5 ppm). The electrochemical tests were performed using a PARSTAT 2273 (Princeton Applied Research) potentiostat. Transistor device characteristics were measured using a B1500A Agilent semiconductor parameter analyzer.