Electronic Supplementary Information

TransCap: a monolithically integrated supercapacitor and electrolyte-gated transistor


a Département de Génie physique, École Polytechnique de Montréal, C.P. 6079, Succ. Centre Ville, H3C 3A7, Canada. E-mail: clara.santato@polymtl.ca
b Department of Chemistry “Giacomo Ciani”, Università di Bologna, Via Selmi, 2, 40126, Italy. E-mail: francesca.soavi@unibo.it
c Département de Génie chimique, École Polytechnique de Montréal, C.P. 6079, Succ. Centre Ville, H3C 3A7, Canada.

Fig. S1. Transfer characteristics of the [N1113][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 N₂ 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 SiO₂ 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 N₂ glove box (O₂, H₂O 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 μg·cm⁻², considering a polymer density of ca 1 g/cm³.¹


Materials: Ionic Liquid

[N₁₁₁₃][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·cm⁻¹.²


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 m²·g⁻¹, 28 mg·mL⁻¹) and polyvinylidene fluoride (PVDF, KYNAR HSV900, 1.4 mg·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·cm⁻². The footprint of the TransCap corresponds to the geometric area of the separator (0.36 cm²).

TransCap electrochemical and electrical characterization

The electrical and electrochemical characterizations of the TransCap were carried out in a N₂ glove box (H₂O, O₂ 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.