Supporting Information

Towards flexibility: Metal free plastic cathodes for Dye sensitized solar cells

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Experimental

Materials:1-butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide, (BMITFSI) were obtained from IoLiTec GmbH, 3,4-ethylenedioxythiophene (EDOT) (*Baytron*,MV-2) from Bayer and ethylene glycol was obtained form Sigma Aldrich and used as received. PEDOT coated PET sheet (Orgacon-Films-4011) obtain my thread coating and was generously provided my AGFA.

The polymer was deposited potentiostatically at a DC potential of +1.2 V using Eco Chemie AUTOLAB in a classical three-electrode system where platinum rod as the counter, and leak free Ag/AgCl as reference electrode. The working electrode was PEDOT coated PET sheet placed parallel in a solution containing BMITFSI and 0.1 M EDOT. The potential was applied for a period of 300 sec, to coat the PEDOT flexible sheets with polymer layers and to use them as metal free charge collector and electro-catalyst. After the polymerization process the film was washed repeatedly with isopropyl alcohol to get rid of any unreacted monomer as well as ionic liquids and annealed 60 ^{o}C for 30 min. To increase the charge transport properties these films were further dipped in ethylene glycol for 30 min. and then annealed at 80 ^{o}C for 15 min.

DSSCs fabrication

FTO glass plates (Nippon Sheet Glass, Solar 4 mm thickness) were immersed in 40 mM $TiCl_4$ *aq.* at 70 °C for 30 min and washed with water and ethanol. A paste composed of 20 nm anatase TiO_2 particles for the transparent nanocrystalline layer was coated on the FTO glass plates by screen printing. The coating-drying procedure was repeated to increase the thickness to a required one. In order to increase the light path by scattering, ~5 μm scattering layer (400 nm, CCIC, HPW-400) was coated on the top of the transparent layer. The TiO_2 electrodes were gradually heated under an air flow. After a second $TiCl_4$ treatment, the TiO_2 electrodes were immersed into a dye solution 0.3mM solution of D21L6 in ethanol and kept at room temperature for 18 h. The dye-adsorbed TiO_2 electrode and counter electrode were assembled into a sealed sandwich type cell with a gap of a hot-melt ionomer film, Surlyn (25 μm, Du-Pont). Four different type of electrolytes were used as: Z960 (1M 1,3-dimethylimidazolium iodide (DMII), 0.05M LiI, 0.03 I_2, 0.1M guanidinium thiocyanate (GuNCS), 0.5M 4-*tert*-butylpyridine (TBP) 15/85 (v/v) mixture of valeronitrile and acetonitrile), JH34 (0.6M DMII, 0.05M LiI, 0.03 I_2, 0.05M GuNCS, 0.25M TBP 15/85 (v/v) mixture of valeronitrile and acetonitrile), JH70 (0.22 M $[Co^{II}(bpy\text{-}pz)_2](PF_6)_2$, 0.05 M $[Co^{III}(bpy\text{-}pz)_2](PF_6)_3$, 0.1 M $LiClO_4$, and 0.2 M TBP in acetonitrile) and JH180 (0.22 M $[Co^{II}(bpy)_3](B(CN)_4)_2$, 0.05 M $[Co^{III}(bpy)_3](B(CN)_4)_3$, 0.1 M $LiClO_4$, and 0.2 M TBP in acetonitrile). In order to reduce scattered light from the edge of the glass electrodes of the dyed TiO_2 layer, a light shading mask was used onto the DSSCs, so the active area of DSSCs was fixed to 0.185 cm^2. Photovoltaic experiments were made according to the earlier described method and the measurement settling time between applying a voltage and measuring a current for the *I-V* characterization of DSSCs was fixed to 40 ms at an interval of 10mV [3,21].

Spin coated PEDOT films were also prepared by a method reported by [8] for this PEDOT:PSS (Baytron P 4183) was mixed with 6 wt.% of ethylene glycol. The solution was then filtered using 0.45mm syringe filter and subsequently spin coated at a speed of 5000 RPM for 30 sec coated on either pre cleaned FTO or glass substrates. These films were then annealed at 120 ^{o}C on a hot plate for 15 minute in laboratory environment. After annealing the substrates were cooled in a bath of ethylene glycol for 30 minutes and finally heated at 120 ^{o}C for 15 minute.

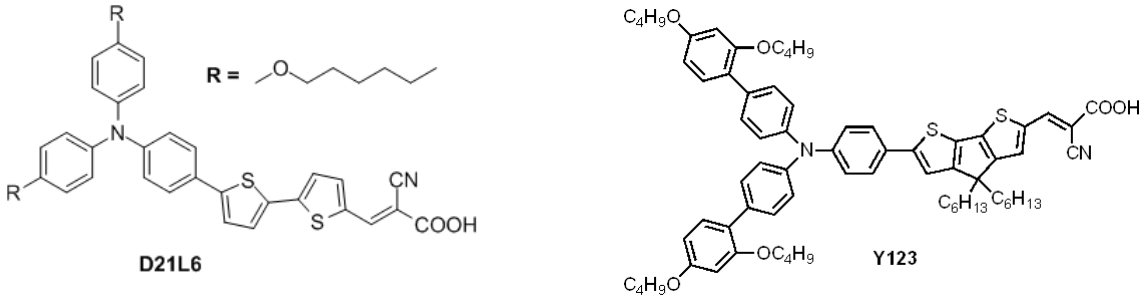

Fig.1. Structure of Dye (a) **21L6** and (b) **Y123**

Table 1: PV parameters obtained using a double layer TiO_2 film (active layer + scattering layer) 8+5+$TiCl_4$ using JH 34 as an electrolyte.

	Light Intensity /PV Parameters	FTO/ Pt	FTO/ PEDOT	Glass /PEDOT
0.1 Sun	**V_{OC} (mV)**	673	648	601
	J_{SC} (mA/cm^2)	1.14	1.1	0.067
	FF	0.732	0.69	0.20
	η (%)	5.90	5.69	0.07
0.5 Sun	**V_{OC} (mV)**	722	693	642
	J_{SC} (mA/cm^2)	5.98	5.4	0.074
	FF	0.711	0.63	0.20
	η (%)	6.05	5.31	0.02
1 Sun	**V_{OC} (mV)**	738	707	655
	J_{SC} (mA/cm^2)	11.55	10.1	0.075
	FF	0.680	0.56	0.2
	η (%)	5.80	4.76	0.01

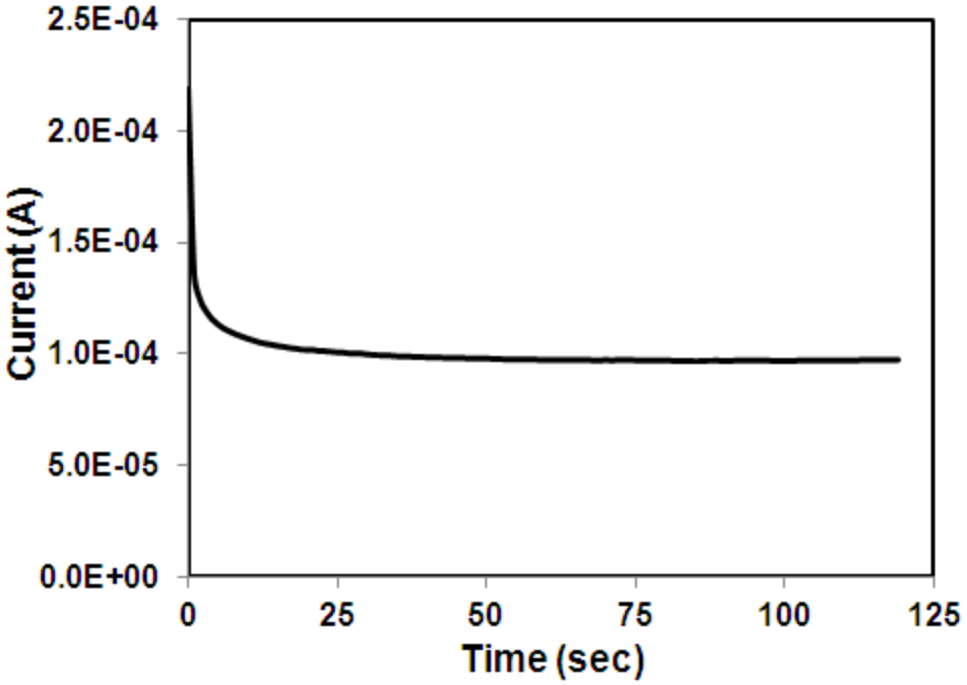

Fig. S2: Potentiotaic growth of PEDOT on PEDOT based sheets at an applied voltage of +1.2V.

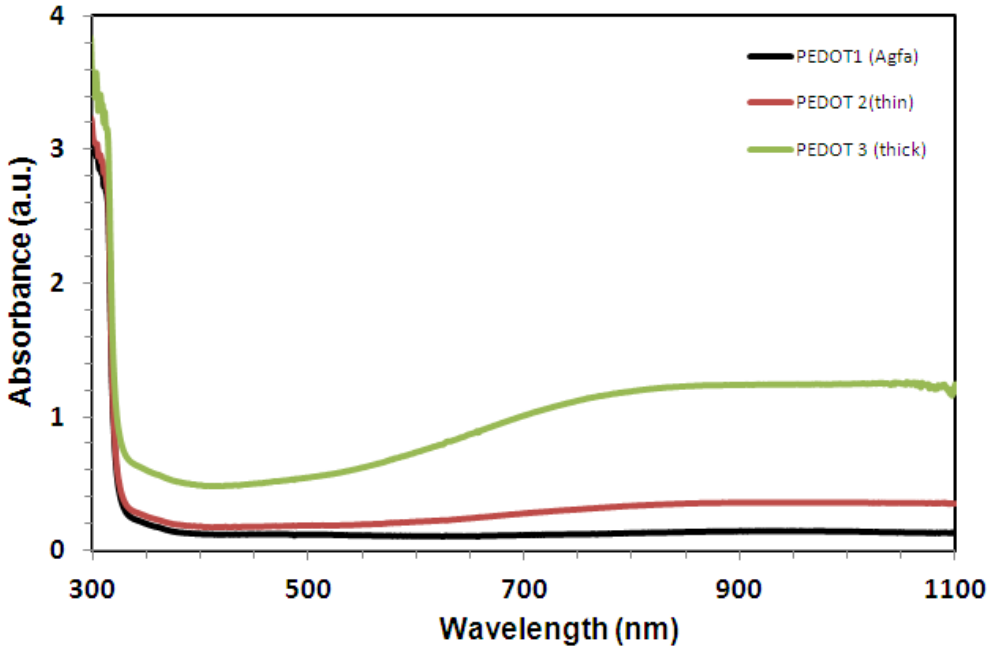

Fig. S3: Absorbance spectra of different PEDOT coated plastic sheets.

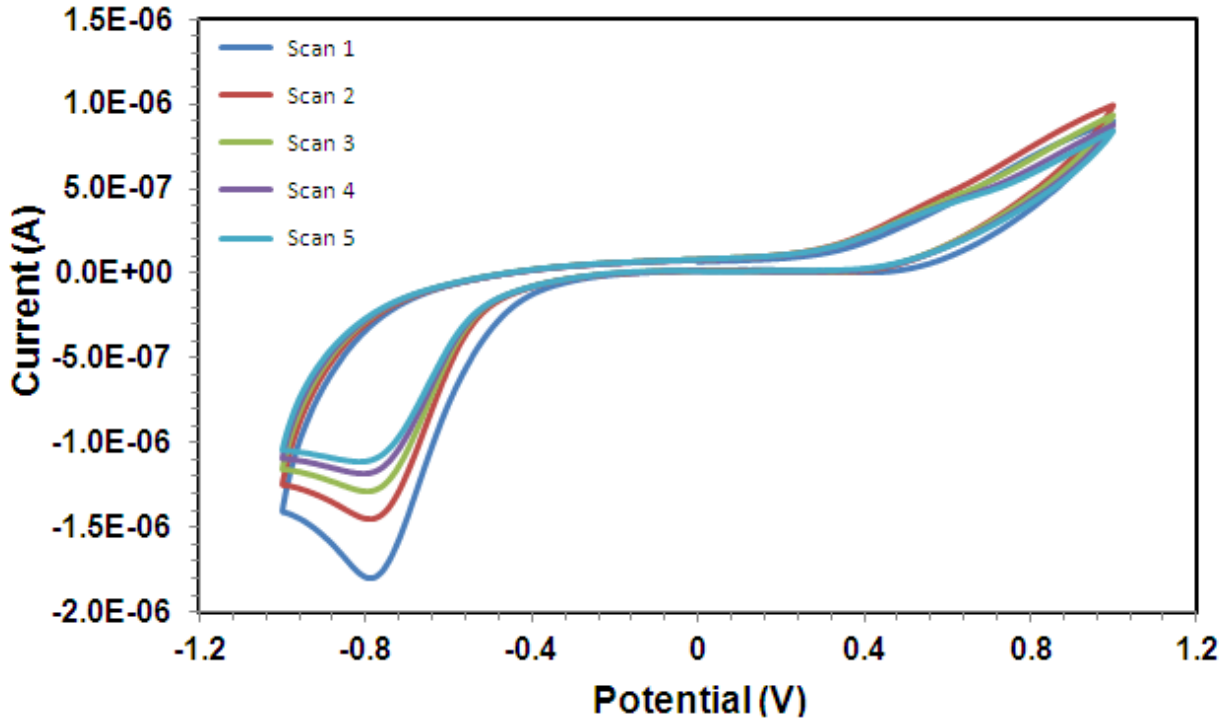

Fig.S4: Cyclic voltammetry of TCO free, PEDOT based DSSCs cathode in a two electrode configuration. The photoanode was used as working electrode while the counter and reference electrode were shorted to each other and connected to PEDOT based cathode. (Electrolyte- JH 180)

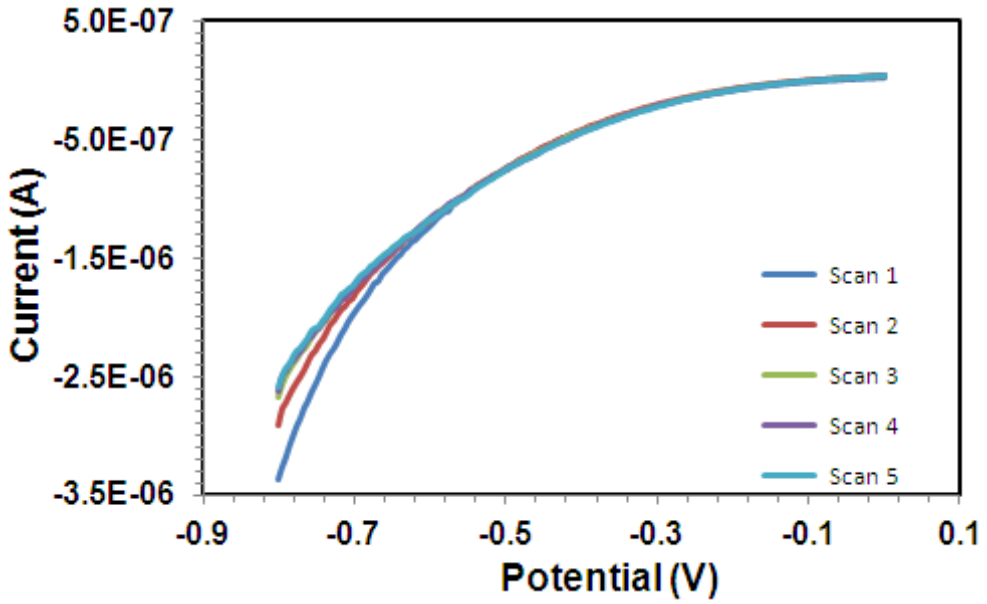

Fig.S5: Linear sweep voltammetry (LSV) TCO free, PEDOT based DSSc cathode in a two electrode configuration using JH-180 as an electrolyte.