Data Article

Dataset on the absorption of PCDTBT:PC\textsubscript{70}BM layers and the electro-optical characteristics of air-stable, large-area PCDTBT:PC\textsubscript{70}BM-based polymer solar cell modules, deposited with a custom built slot-die coater

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A B S T R A C T

The data presented in this article is related to the research article entitled “Fabrication of air-stable, large-area, PCDTBT:PC\textsubscript{70}BM polymer solar cell modules using a custom built slot-die coater” (D.I. Kutsarov, E. New, F. Bausi, A. Zoladek-Lemanczyk, F.A. Castro, S.R.P. Silva, 2016) [1]. The repository name and reference number for the raw data from the abovementioned publication can be found under: https://doi.org/10.15126/surreydata.00813106. In this data in brief article, additional information about the absorption properties of PCDTBT:PC\textsubscript{70}BM layers deposited from a 12.5 mg/ml and 15 mg/ml photoactive layer dispersion are shown. Additionally, the best and average J-V curves of single cells, fabricated from the 10 and 15 mg/ml dispersions, are presented.

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### Specifications Table

| Subject area | Electronic Engineering, Physics |
|--------------|---------------------------------|
| More specific subject area | Nanotechnology, Renewable energy, Material science |
| Type of data | Figures |
| How data was acquired | Optical characterization and Electro-optical measurement of device characteristics |
| Data format | Plotted and analyzed |
| Experimental factors | The layers with the photoactive ink were deposited on glass substrates with a custom built slot-die coater and their absorption spectra was measured. Complete solar cells were fabricated and characterized with a solar simulator at 1 Sun. The data plotted represents the raw measurement data. |
| Data source location | No GPS signal and therefore coordinates could be obtained in the Clean room of the ATI at the University of Surrey. Nevertheless, according to Google maps, the coordinates are 51°14'36.0"N 0°35'39.2"W |
| Data accessibility | The data is with this article. A detailed excel spreadsheet with the raw data for the original article by Kutsarov et al. [1], however, can be found in the public repository here: [https://doi.org/10.15126/surreydata.00813106](https://doi.org/10.15126/surreydata.00813106) |

### Value of the data

- A custom built slot-die coater was used to deposit PCDTBT:PCBM layers from dispersions with different concentrations in order to optimize coating parameters and accomplish the deposition of reproducible and homogeneous layers at different temperatures.
- PCDTBT:PCBM-based single cells were fabricated from different photoactive layer inks to investigate the effect of the dispersion concentration on the device characteristics.
- The data can be used as a comparison and a benchmark for other researchers, who work on the field of fabrication of large-area polymer solar cells.

### Data

#### 1. Thin film characterization

The dataset in this article shows a dependence of the PCDTBT:PCBM layer properties on the deposition temperature. This is directly related to an alteration of the optical density of the deposited film and hence, the thickness of the films in Figs. 1 and 2. The measured thickness for photoactive inks with concentrations of 10, 12.5, and 15 mg/ml, which were deposited at 50, 70, and 90 °C, are reported by Kutsarov et al. [1], whereas the raw data, used for the compiling of the graph, is furthermore included in the excel spread sheet in the public repository.

#### 2. Solar cell characterization

The J–V characteristics of PCDTBT:PC70BM based devices, which were fabricated from a 10 and 15 mg/ml photoactive layer dispersion, are shown in Figs. 3 and 4, respectively. The detailed device characteristics are shown in Supplementary information Table S1 and S2 by Kutsarov et al. [1]. It can be seen that the average characteristics of the cells are reduced, compared to the characteristics of the best performing cell. This is due to fabrication defects, as reported by Kutsarov et al. [1].
Fig. 1. Average UV–vis spectra of PCDTBT:PC$_{70}$BM layers coated at different temperatures for a fixed solution concentration of 15 mg/mL. The UV–vis spectra were measured at position P2 for each sample as reported by Kutsarov et al. [1].

Fig. 2. Average UV–vis spectra of PCDTBT:PC$_{70}$BM layers coated at different temperatures for a fixed solution concentration of 12.5 mg/mL. The UV–vis spectra were measured at position P2 for each sample as reported by Kutsarov et al. [1].

Fig. 3. J–V characteristics of the best performing single cell (based on 12 cells from 2 modules) and the average J–V curve of 12 single cells under illumination and in the dark as reported by Kutsarov et al. [1].
3. Experimental design, materials and methods

3.1. Materials

For the optical characterization in this data in brief, PCDTBT:PC$_{70}$BM layers were deposited with a custom built slot-die coater on glass substrates. The photoactive layer ink consisted of the donor material PCDTBT (SOL 4280, Solaris Chem Inc.) and [6]-Phenyl-C$_{71}$-butyric acid methyl ester (PC$_{70}$BM, Solenne BV) as the acceptor material. PCDTBT and PC$_{70}$BM were mixed in a 1:4 wt ratio and dispersed in a 3:1 solvent mixture by volume of anhydrous o-DCB and CB (1,2-dichlorobenzene and chlorobenzene) to achieve a total concentration of 35 mg/mL. The donor-acceptor mixture was stirred at room temperature until complete dissolution and then diluted to a desired concentration (10, 12.5, or 15 mg/ml).

4. Sample and solar cell fabrication

Prior to the deposition of the PCDTBT:PC$_{70}$BM dispersion, the glass substrates were cleaned in an ultrasonic bath sequentially for 5 min in Decon 90 detergent solution with deionized water (DI), DI, acetone, and methanol. Then, the substrates were blown dry with a nitrogen gun and treated with an oxygen plasma for 5 min (100 W, 15 sccm O$_2$, Emitech K1050X plasma cleaner). The PCDTBT:PC$_{70}$BM layers were deposited under ambient conditions on top of the glass substrate, at a substrate temperature of 50°C, 70°C, or 90°C. A flow rate of 100 µl/min, coating speed of 18 mm/s, and a screw gap of 200 µm were used. After the deposition, the layers were annealed for 10 min at 70 °C to ensure the evaporation of any excess solvents. The complete devices comprised an inverted structure of glass-ITO/ZnO/PCDTBT:PC$_{70}$BM/MoO$_3$/Al and were fabricated according to the experimental details reported by Kutsarov et al. [1].

5. Methods

To characterize the PCDTBT:PC$_{70}$BM layers absorption spectra, UV–visible (UV–vis) spectroscopy was used (Varian Cary 5000 UV–vis–NIR spectrophotometer). The spectra were recorded through a shadow mask with a circular opening (diameter of 5 mm), which was placed at the center of the slot-die coated layer as reported by Kutsarov et al. [1]. The reported spectra represent the average of two spectra, measured for each sample in the wavelength range from 300 nm to 900 nm relative to a glass reference.
Current–voltage (I–V) characterization was conducted using a Keithley 2400 source measurement apparatus in a four-wire setup in ambient atmosphere with an ORIEL solar simulator (class ABA) at AM 1.5 G. A silicon reference cell (PV Measurements, Inc. 20 mm × 20 mm) was used for the calibration of the illumination source to 1 Sun (100 mW/cm²).

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Transparency document. Supporting information

Transparency data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2017.01.003.

Reference

[1] D.I. Kutsarov, E. New, F. Bausi, A. Zoladek-Lemanczyk, F.A. Castro, S.R.P. Silva, Fabrication of air-stable, large-area, PCDTBT:PC_{70}BM polymer solar cell modules using a custom built slot-die coater, Sol. Energy Mater. Sol. Cells 161 (2017) 388–396.