CELL FABRICATION

LAYER	MATERIAL	FABRICATION PROCESS	THICKNESS OF THE LAYER	RPM / TIME
SUBSTRATE	ITO(10cm2)	-	30nm	
HTL	PEDOT	SPIN COATING		4000rpm for 25s
ACTIVE LAYER	P3HT-PCBM	SPIN COATING		2000 rpm for 60s
ETL	zno	SPIN COATING		
ELECTRODE	Ag nws	SPIN COATING		2000 rpm for 50 s to

FABRICATION STEPS

- To prepare the small-area TPV devices (Glass/ITO/PEDOT/PTB7-Th:IEICO-4F/ ZnO/Ag NWs), the following steps were used.

- 1. The ITO substrate was ultrasonically cleaned with surfactants, deionized water and isopropanol in sequence.

HTL LAYER –

- PEDOT (diluted to 50% by water for use) was spin-coated on the ITO at 4000 rpm for 25 s, and then annealed at 120 °C for 10 min

ACTIVE LAYER -

- . PTB7-Th and IEICO-4F were dissolved in chlorobenzene with 4% CN additive, and spin-coated on the PEDOT layer at 2000 rpm for 60 s, annealing at 100 °C for 10 min.

- By changing the ratio of donor and acceptor and the total concentration of the active layer solution, to obtain the active lightabsorbing layer with different thicknesses.

-

FABRICATION STEPS

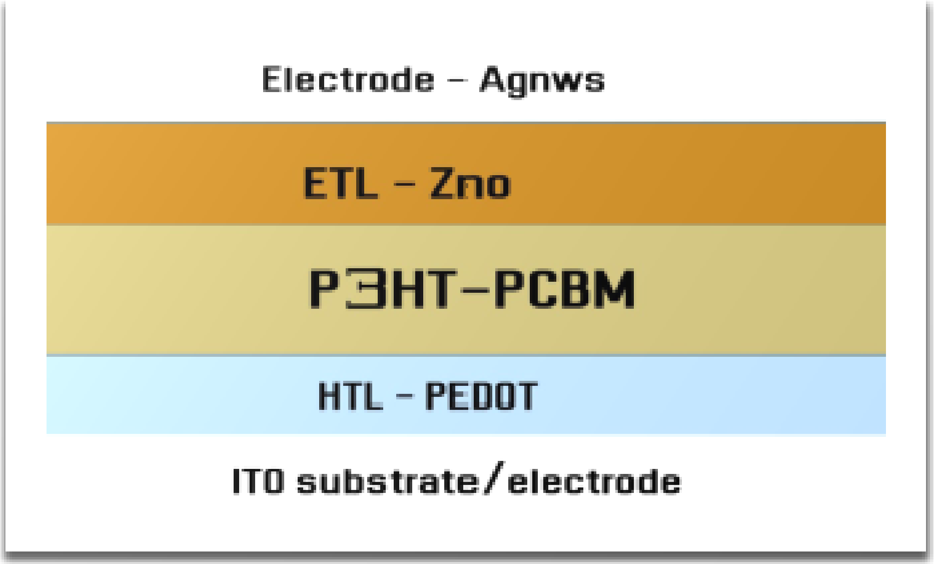
ETL LAYER :

- The ZnO nanoparticles was then spin-coated on the active layer to form the electron transport layer.

ELECTRODE :

. Next, Ag NWs were spin-coated on the ZnO layer at 2000 rpm for 50 s to form the top transparent electrode.

Fabrication model



ALTERNATIVE MATERIALS ..

- ALTERNATIVE MATERIALS USED FOR EACH LAYER :

- ELECTRODEs (TCO) =1. ITO(most commonly used electrode)

2. Agnws (silver nanowires (AgNWs) are introduced, as the primary material to replace indium tin oxide for fabricating cost-effective flexible organic solar cells (FOSCs), because of their remarkable solution-processing, flexibility, transparency, and conductivity, along with their enhanced properties in terms of light-scattering, plasmonic effects, and transmittance in the near infrared region

3. FTO = [If the process involves high temperatures (>250 C), it is better choice to use FTO instead if ITO because ITO loses its conductivity at high temperatures

- Alternate materials for electron transport layer : Tio2 , Zno ,
  but we choose Zno because ZnO features good transparency, low thermal expansion, high thermal resistance

- Alternate materials for Hole transport layer :
  Most commonly used as a hole transport layer is the material PEDOT:PSS, which offers desired properties such as transparency, simple processing and good ohmic contact between anode and photoactive ma- terial.
  but P3HT, PTTA, also considerable as an alternative material .

- Alternate materials for active layer : PCDTBT:$PC_{71}BM$ (transparency level – 40%) - currently using material : PTB7-Th and IEICO-4F (transparency level – 73%)

- Alternate materials for each layer :

LAYER	ALTERNATIVE MATERIAL
SUBSTRATE /ELECTRODE	FTO layerd glass = [If the process involves high temperatures (>250 C)
HTL(HOLE TRANSPORT LAYER)	P3HT, PTTA
ACTIVE LAYER	PCDTBT:$PC_{71}BM$ (transparency level – 40%)
ETL (ELECTRON TRANSPORT LAYER)	Tio2
COUNTER ELECTRODE	ITO

The best alternative method for spin coating is :

- ~10 micron thick nanocrystalline TiO_2 film was deposited on conducting PET plastics by various methods such as spray coating , spin coating, and screen printing.

(Krishna C. Mandal, Anton Smirnov, D. Peramunage and R. David Rauh (2002). Low-Cost, Large-Area Nanocrystalline TiO_2 -Polymer Solar Cells on Flexible Plastics. MRS Proceedings, 737, F8.45 doi:10.1557/PROC-737-F8.45.)

- So if we want to deposit ~10 micron thick layer and above we can use spray coating and screen printing as an alternative fabrication method for spin coating technique

- In this review, silver nanowires (AgNWs) are introduced, as the primary material **to replace indium tin oxide for fabricating cost-effective flexible organic solar cells** (FOSCs), because of their remarkable solution-processing, flexibility, transparency, and conductivity, along with their enhanced properties in terms of ...

BILL OF MATERIALS

- ITO SUBSTRATE – RS – 379
- ITO Glass Substrate - Carbon Conductive tape Manufacturer from Nagpur (indiamart.com)

ITO Glass Substrate

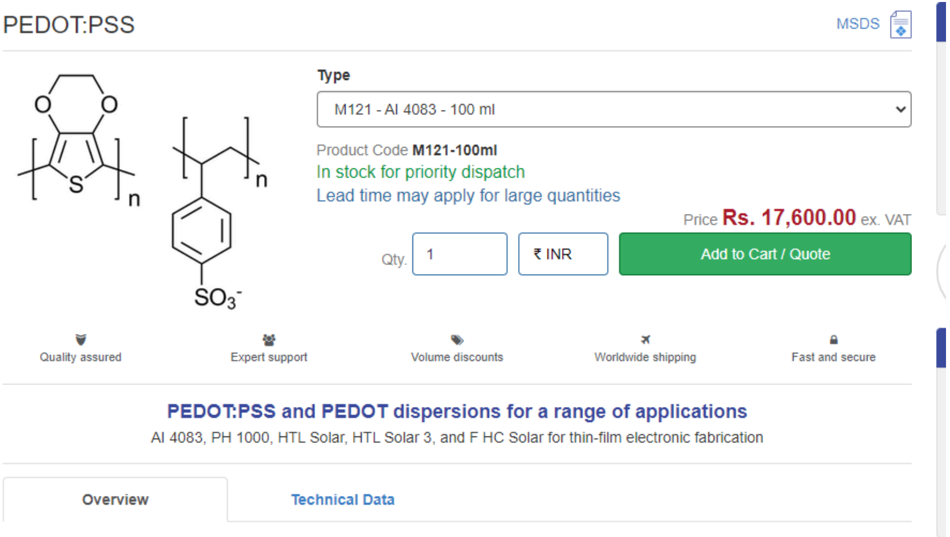
Rs 379 / Piece Get Latest Price

Product Brochure Watch Video

Brand	Techinstro
Size	25mm x 25mm x 1.1mm
Usage/Application	research and development
Material	ITO on Soda lime glass
Thickness Of Slide	1.1mm
Shape	Square
Application	Industrial, Chemical Laboratory

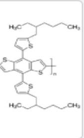
ITO Glass Substrate

ITO Glass Substrate belongs to the catagory of TCO coated glasses. The **ITO Glass Substrate** has a property of low sheet resistance and high transmittance.



- HOLE TRANSPORT LAYER
- PEDOT PSS AL 4083 – 100ml – Rs – 17600
- PEDOT:PSS | PH1000, AI4083, HTL Solar & HTL Solar 3, F HC Solar | Ossila

- PTB7-Th (ACTIVE MATERIAL)
- [PTB7-Th 1469791-66-9 (sigmaaldrich.com)](#)



794333 Sigma-Aldrich.

PTB7-Th

(0)

Synonym(s):
PCE-10, Poly([2,6'-4,8-di(5-ethylhexylthienyl)benzo[1,2-b;3,3-b]dithiophene]{3-fluoro-2[(2-ethylhexyl)carbonyl]thieno[3,4-b]thiophenediyl})

Linear Formula:
$(C_{49}H_{57}FO_2S_6)_n$

CAS Number: 1469791-66-9 **NACRES:** NA.23

SKU	Pack Size	Availability	Price	Quantity
794333-100MG	100 MG	Available to ship on September 28, 2022 Details...	₹42,715.45	− +

A

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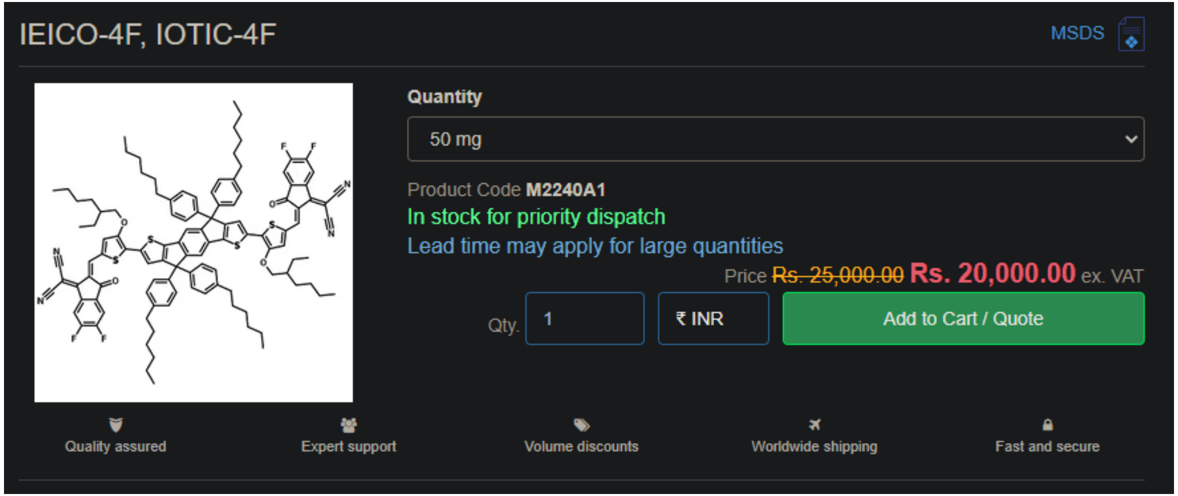
cuments »

Request a Bulk Order

Add to Cart



- IEICO – 4F (ACTIVE MATERIAL)
- https://www.ossila.com/en-in/products/ieico-4f?variant=36037448695971

- FOR THE PREAPARATION OF ZNO (ETL) LAYER :
- Perovskite solar cells with a planar heterojunction structure prepared using room-temperature solution processing techniques | Nature Photonics

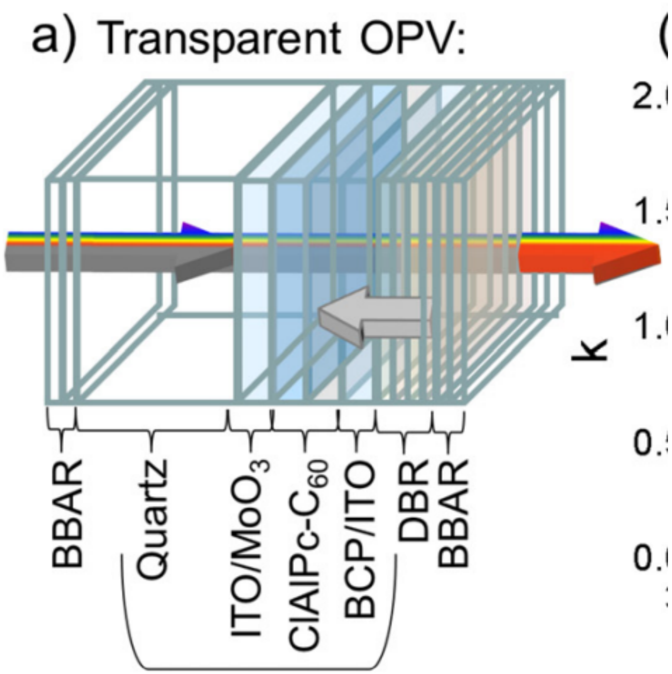
BILL OF MATERIALS (Tabular)

Material	QUANTITY	Cost	Requird in ml
ITO GLASS	1 piece	Rs/- 379	
HTL layer (pedot pss)	100ml	Rs/- 17600	
Active layers (PTB7-Th)	100mg		

ANALYSIS ON MIT (Massachusetts Institute of Technology) SOLAR CELL

- sequentially deposited via thermal evaporation

TRANSPARENT SUBSTRATE	QUARTZ (thermal evaporation)
ELECTRODE	ITO(thermal evaporation)
ETL	MOo3(thermal evaporation)
ACTIVE LAYER	CIAIPc-C60(thermal evaporation)
HTL	BCP(thermal evaporation)
COUNTER ELECTRODE	ITO (rf-sputtering)



Lunt, Richard R., and Vladimir Bulovic. "Transparent, Nearinfrared Organic Photovoltaic Solar Cells for Window and Energy-scavenging Applications." Applied Physics Letters 98.11 (2011): 113305.

- Simulation softwares list :

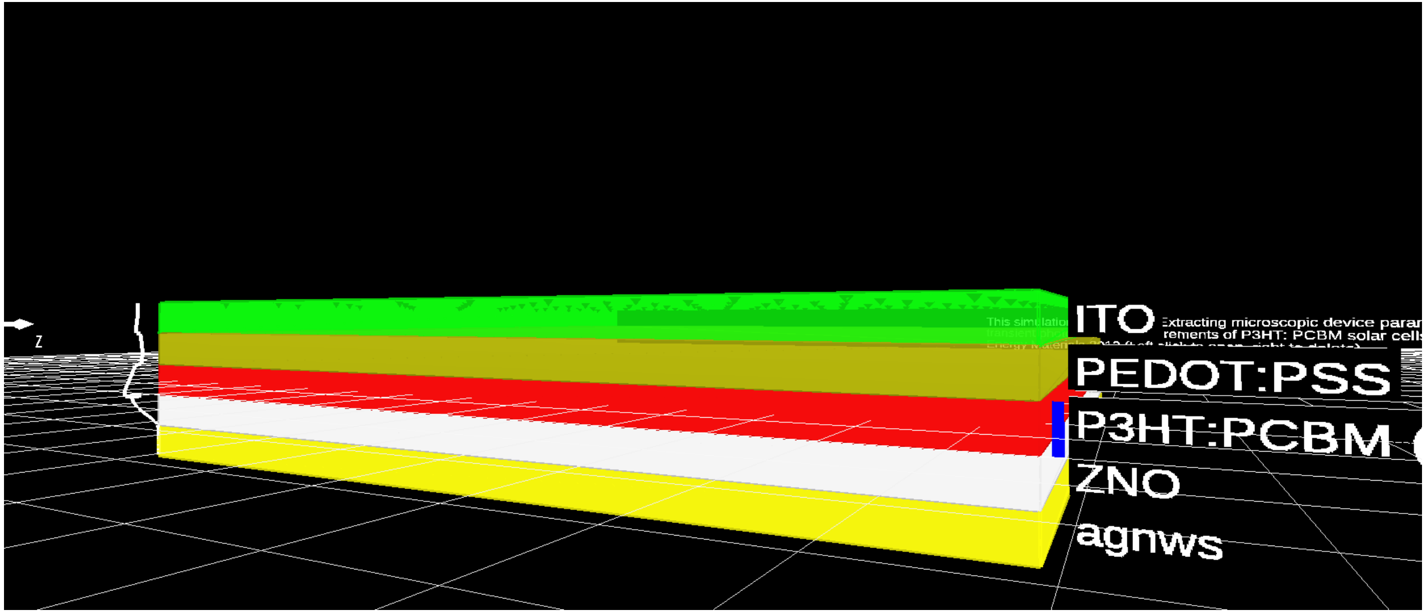
Solar Cells

(- free software available)

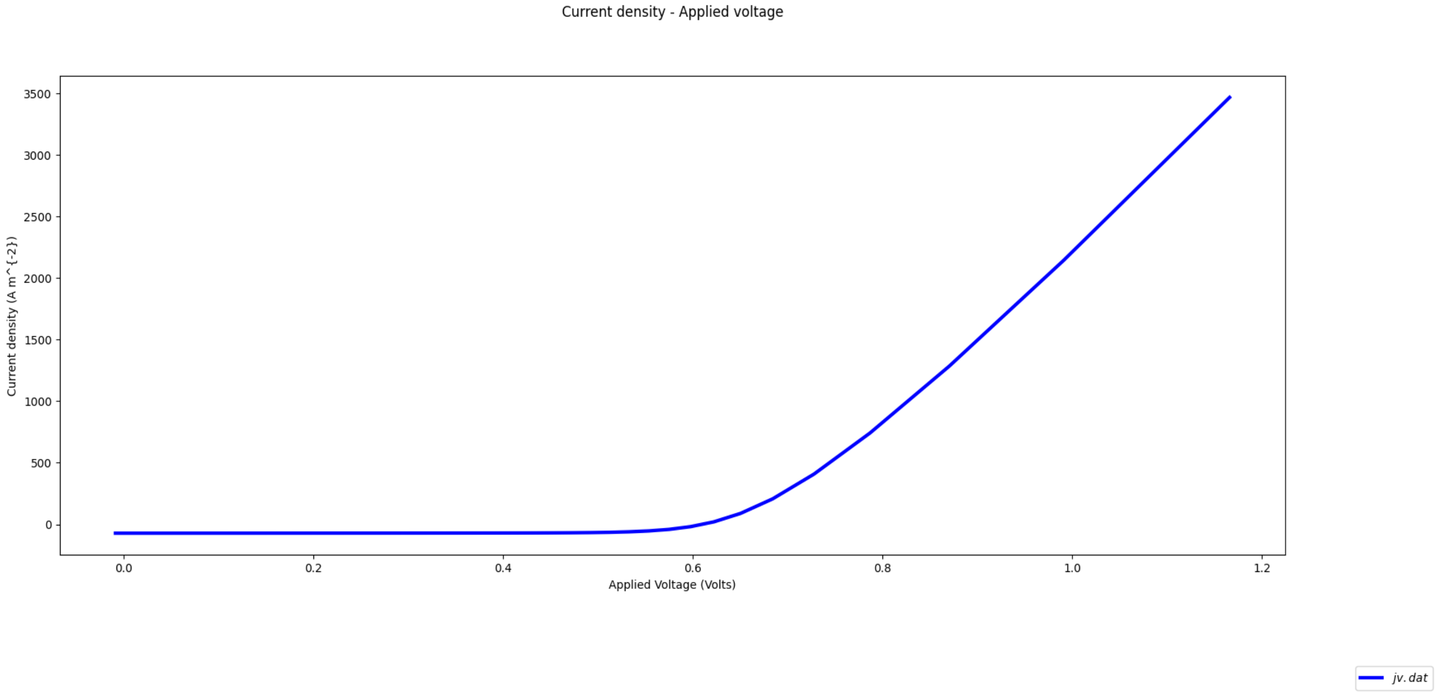
- AFORS-HET (Helmholtz Center Berlin, Germany)
- AMPS-1D (Pennsylvania State University, USA)
- ASPIN3 (University of Ljubljana, Slovenia)
- CROWM (University of Ljubljana, Slovenia)
- GPVDM (University of Nottingham, UK)
- PC-1D (University of New South Wales, Australia)
- PV Lighthouse: software collection for photovoltaics
- RaySim (University of New South Wales, Australia): ray-tracing
- SETFOS (Fluxim AG) - thin-film photovoltaics
- Solcore Phyton-based library of tools
- Solis (Université de Lorraine, France)
- SunShine (University of Ljubljana, Slovenia)

please send updates to software(at)nusod.org

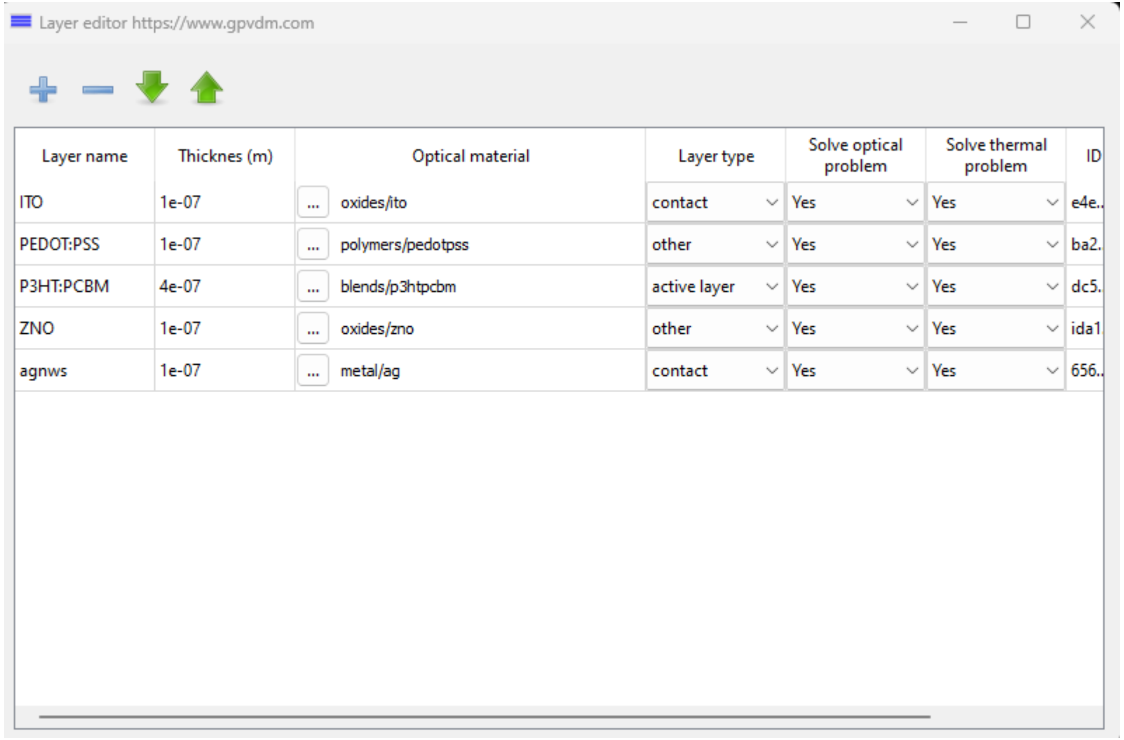
3D SIMULATION OF SOLAR CELL



JV CURVE AT INITIAL VALUES :



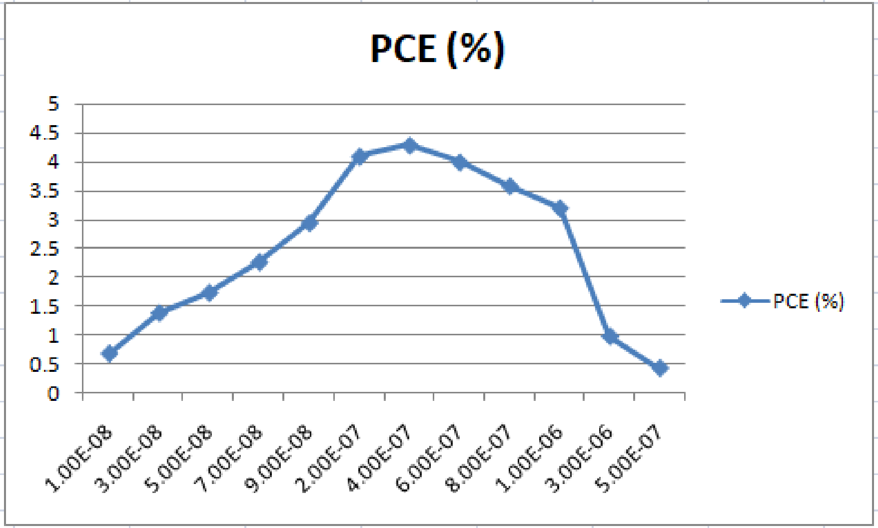
Case -1 changing active layer thickness



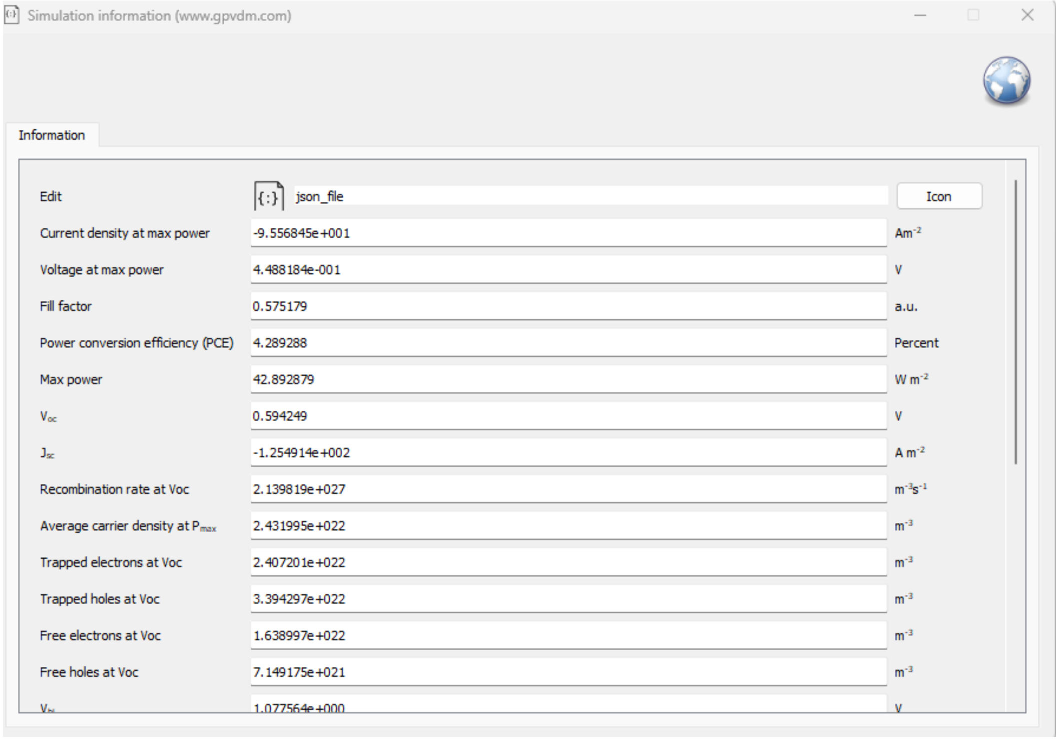
Layer name	Thicknes (m)	Optical material	Layer type	Solve optical problem	Solve thermal problem	ID
ITO	1e-07	... oxides/ito	contact	Yes	Yes	e4e..
PEDOT:PSS	1e-07	... polymers/pedotpss	other	Yes	Yes	ba2.
P3HT:PCBM	4e-07	... blends/p3htpcbm	active layer	Yes	Yes	dc5.
ZNO	1e-07	... oxides/zno	other	Yes	Yes	ida1
agnws	1e-07	... metal/ag	contact	Yes	Yes	656..

case 1

Thickness (m) of thelayer	PCE (%)
1.00E-08	0.6725
3.00E-08	1.3769
5.00E-08	1.7298
7.00E-08	2.2623
9.00E-08	2.9408
2.00E-07	4.0945
4.00E-07	4.2892
6.00E-07	3.9949
8.00E-07	3.5825
1.00E-06	3.1994
3.00E-06	0.9717
5.00E-07	0.4201



Here we can see that active layer (P3HT-PCBM) thickness at 4E-07m(400nm) shows the maximum efficiency so by fixing active layer thickness at 4E-07m(400nm) and we change ther layer thickness one by one...



Simulation information (www.gpvdm.com)

Information

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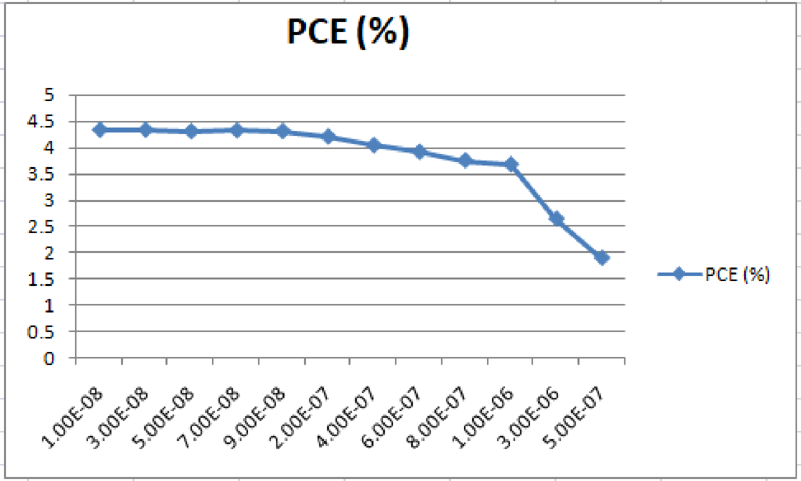
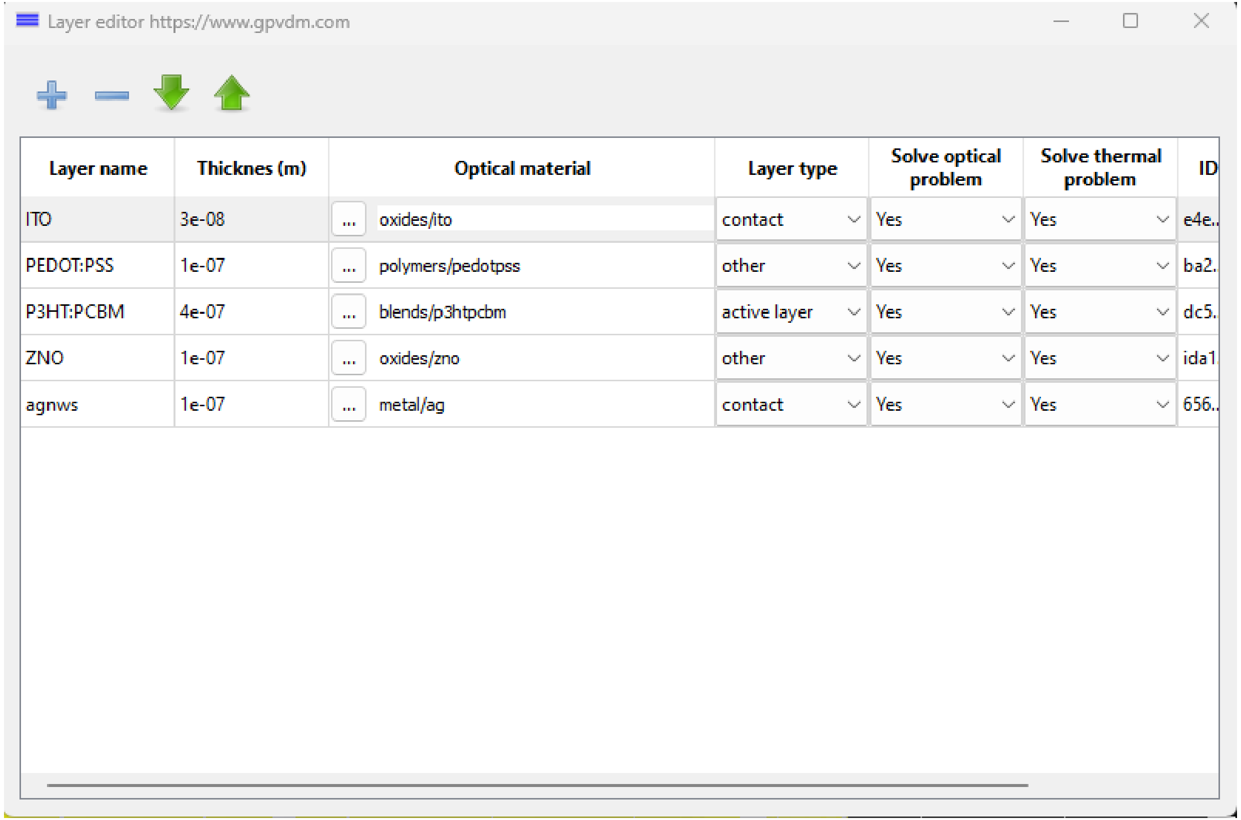
Current density at max power	-9.556845e+001	Am^{-2}
Voltage at max power	4.488184e-001	V
Fill factor	0.575179	a.u.
Power conversion efficiency (PCE)	4.289288	Percent
Max power	42.892879	$W\ m^{-2}$
V_{oc}	0.594249	V
J_{sc}	-1.254914e+002	$A\ m^{-2}$
Recombination rate at Voc	2.139819e+027	$m^{-3}s^{-1}$
Average carrier density at P_{max}	2.431995e+022	m^{-3}
Trapped electrons at Voc	2.407201e+022	m^{-3}
Trapped holes at Voc	3.394297e+022	m^{-3}
Free electrons at Voc	1.638997e+022	m^{-3}
Free holes at Voc	7.149175e+021	m^{-3}
V_{bi}	1.077564e+000	V

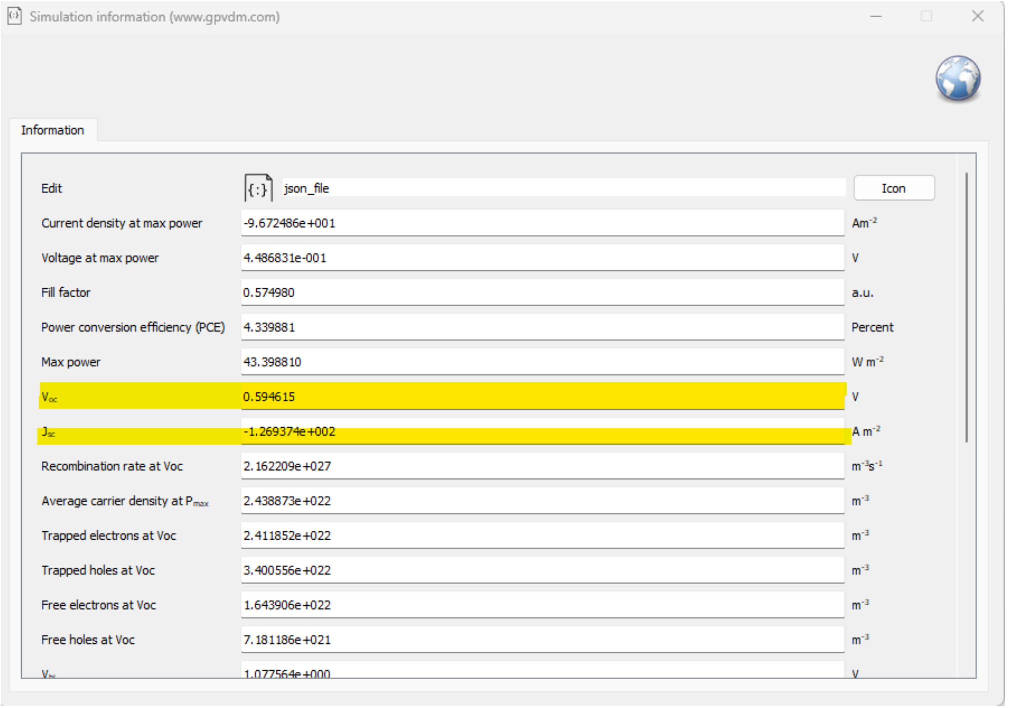
Case 2 : chaging the thickness of ITO (electrdoe)

case 2	
Thickness (m) of thelayer	PCE (%)
1.00E-08	4.338
3.00E-08	4.339
5.00E-08	4.311
7.00E-08	4.328
9.00E-08	4.314
2.00E-07	4.21
4.00E-07	4.046
6.00E-07	3.918
8.00E-07	3.756
1.00E-06	3.679
3.00E-06	2.641
5.00E-07	1.893



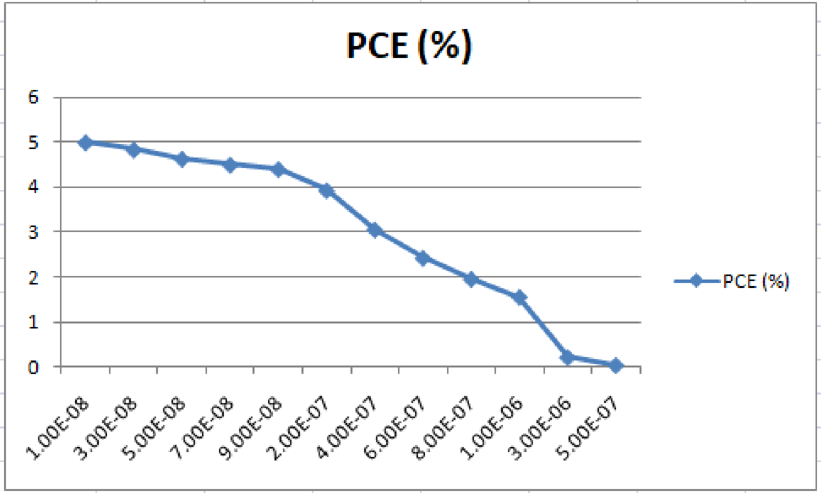


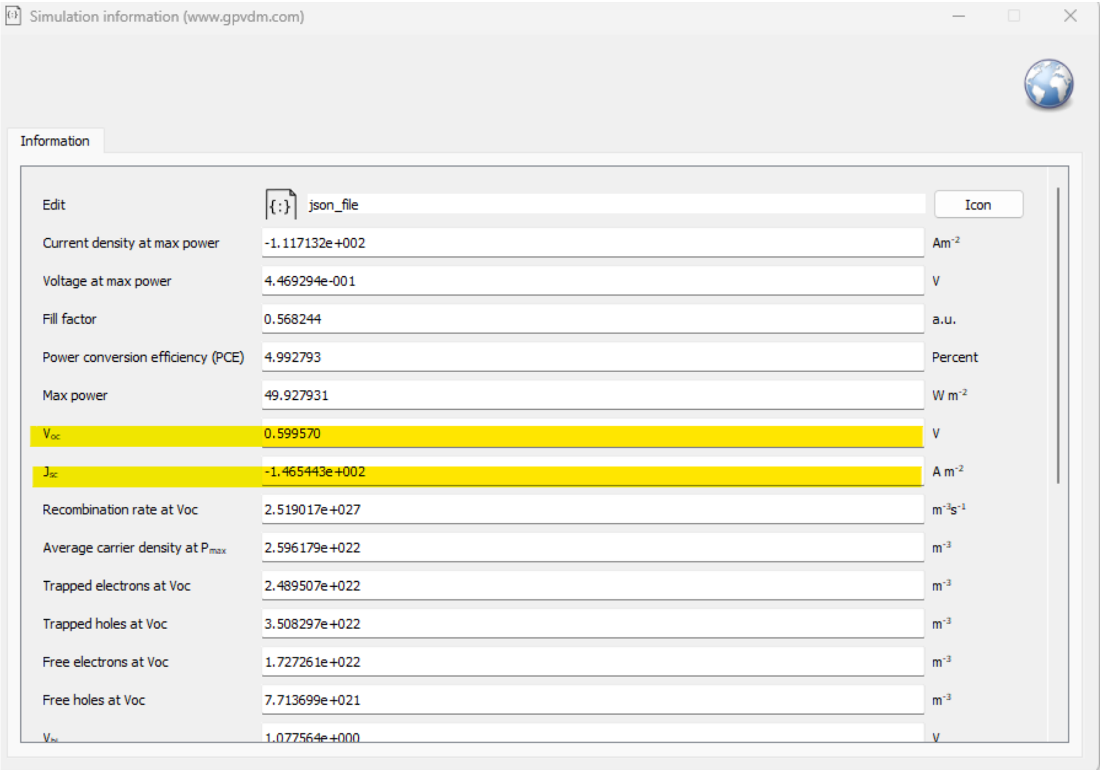
Layer name	Thicknes (m)	Optical material	Layer type	Solve optical problem	Solve thermal problem	ID
ITO	3e-08	... oxides/ito	contact	Yes	Yes	e4e..
PEDOT:PSS	1e-07	... polymers/pedotpss	other	Yes	Yes	ba2.
P3HT:PCBM	4e-07	... blends/p3htpcbm	active layer	Yes	Yes	dc5.
ZNO	1e-07	... oxides/zno	other	Yes	Yes	ida1
agnws	1e-07	... metal/ag	contact	Yes	Yes	656..


Simulation information (www.gpvdm.com)
Information
Edit
json_file
Icon
Current density at max power
-9.672486e+001
Am-2
Voltage at max power
4.486831e-001
V
Fill factor
0.574980
a.u.
Power conversion efficiency (PCE)
4.339881
Percent
Max power
43.398810
W m-2
Voc
0.594615
V
Jsc
-1.269374e+002
A m-2
Recombination rate at Voc
2.162209e+027
m-3s-1
Average carrier density at Pmax
2.438873e+022
m-3
Trapped electrons at Voc
2.411852e+022
m-3
Trapped holes at Voc
3.400556e+022
m-3
Free electrons at Voc
1.643906e+022
m-3
Free holes at Voc
7.181186e+021
m-3
1.077564e+000
V

Case3 : changing HTL layer thickness

case 3	
Thickness (m) of thelayer	PCE (%)
1.00E-08	4.9927
3.00E-08	4.8327
5.00E-08	4.6266
7.00E-08	4.4944
9.00E-08	4.3954
2.00E-07	3.9245
4.00E-07	3.0518
6.00E-07	2.4207
8.00E-07	1.9534
1.00E-06	1.5547
3.00E-06	0.2122
5.00E-07	0.0337





Simulation information (www.gpvdm.com)
Information
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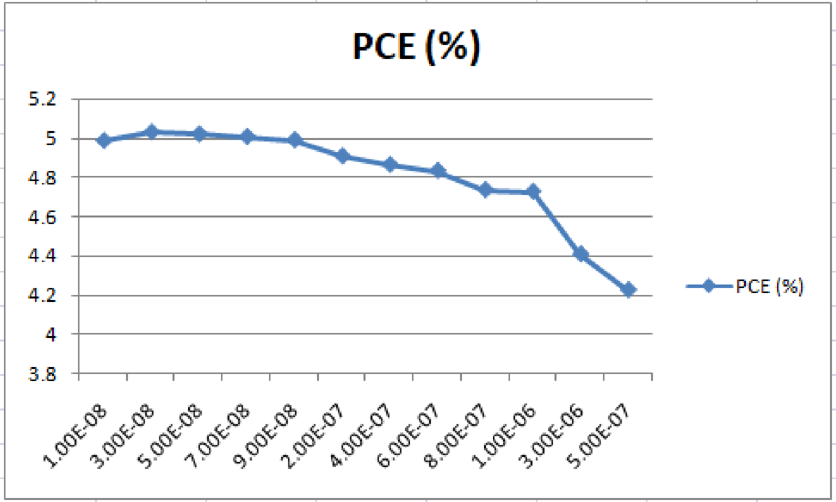
json_file
Icon
Current density at max power
-1.117132e+002
Am-2
Voltage at max power
4.469294e-001
V
Fill factor
0.568244
a.u.
Power conversion efficiency (PCE)
4.992793
Percent
Max power
49.927931
W m-2
Voc
0.599570
V
Jsc
-1.465443e+002
A m-2
Recombination rate at Voc
2.519017e+027
m-3s-1
Average carrier density at Pmax
2.596179e+022
m-3
Trapped electrons at Voc
2.489507e+022
m-3
Trapped holes at Voc
3.508297e+022
m-3
Free electrons at Voc
1.727261e+022
m-3
Free holes at Voc
7.713699e+021
m-3
1.077564e+000
V

Case: 4 changing ETL layer thickness..

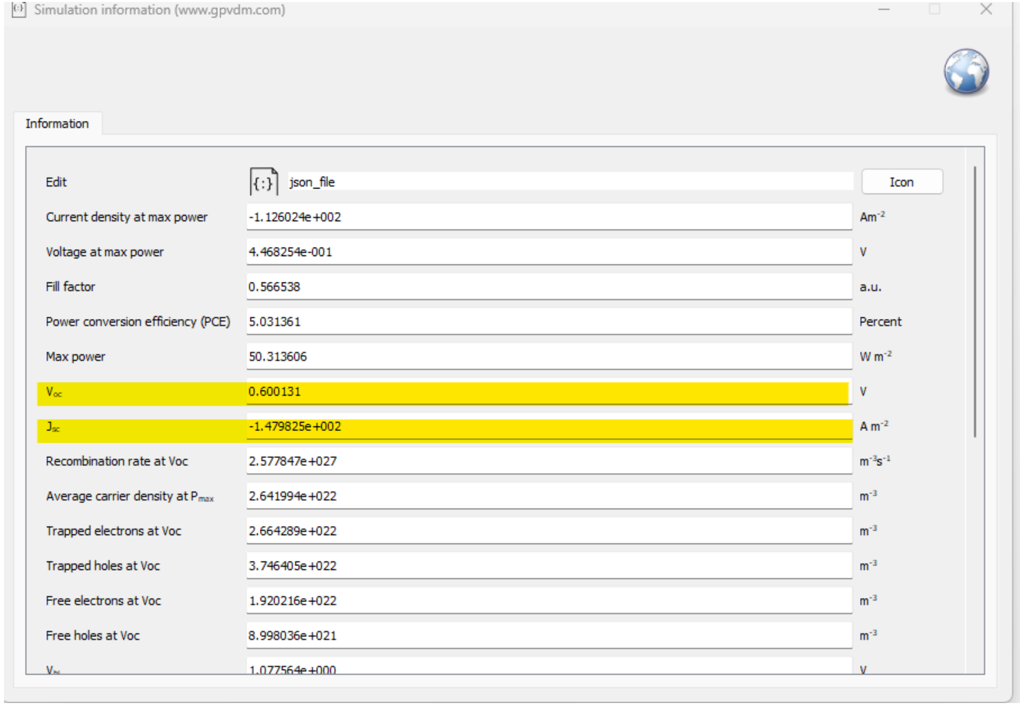
case 4	
Thickness (m) of thelayer	PCE (%)
1.00E-08	4.9867
3.00E-08	5.0313
5.00E-08	5.0203
7.00E-08	5.0072
9.00E-08	4.9902
2.00E-07	4.9081
4.00E-07	4.8644
6.00E-07	4.834
8.00E-07	4.7357
1.00E-06	4.7275
3.00E-06	4.4084
5.00E-07	4.2254



Final thickness of all layers to achieve best efficiency

Layer editor https://www.gpvdm.com

Layer name	Thicknes (m)	Optical material	Layer type	Solve optical problem	Solve thermal problem	ID
ITO	3e-08	... oxides/ito	contact	Yes	Yes	e4e..
PEDOT:PSS	1e-08	... polymers/pedotpss	other	Yes	Yes	ba2.
P3HT:PCBM	4e-07	... blends/p3htpcbm	active layer	Yes	Yes	dc5.
ZNO	3e-08	... oxides/zno	other	Yes	Yes	ida1
agnws	1e-07	... metal/ag	contact	Yes	Yes	656..



Simulation information (www.gpvdm.com)

Information

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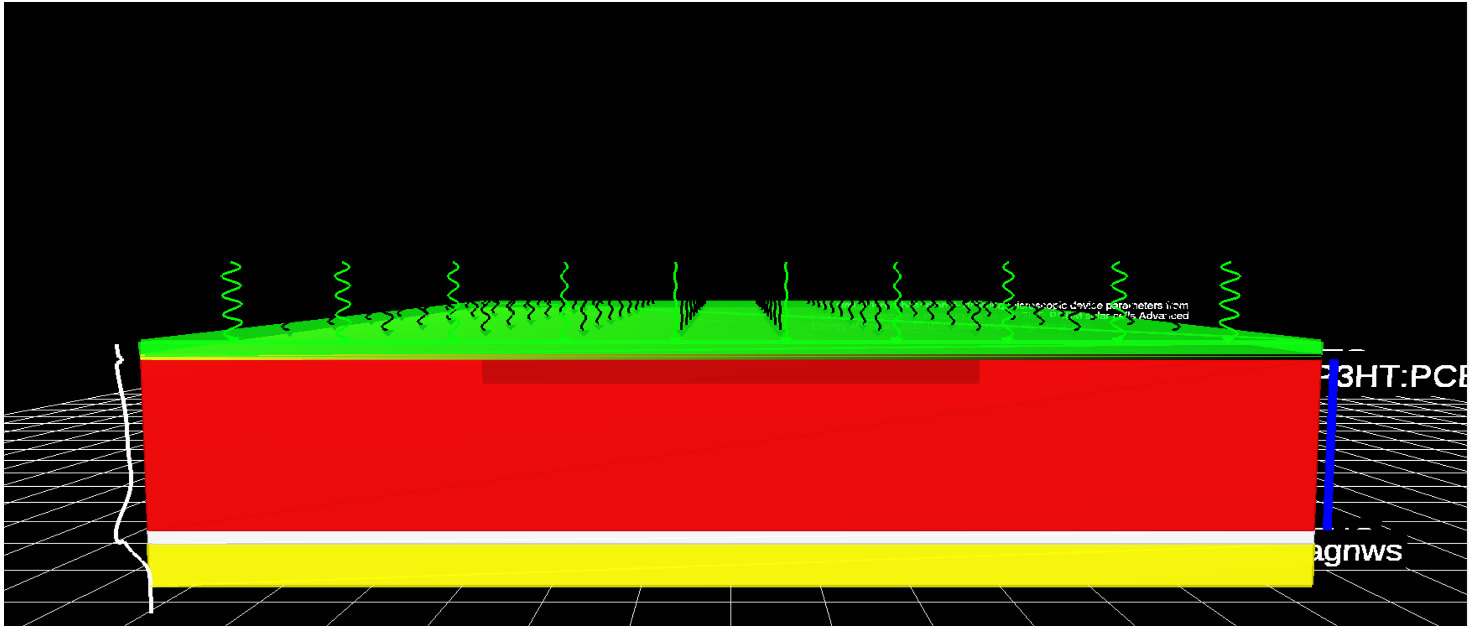
Voltage at max power	4.468254e-001	V
Fill factor	0.566538	a.u.
Power conversion efficiency (PCE)	5.031361	Percent
Max power	50.313606	$W\ m^{-2}$
V_{oc}	0.600131	V
J_{sc}	-1.479825e+002	$A\ m^{-2}$
Recombination rate at Voc	2.577847e+027	$m^{-3}s^{-1}$
Average carrier density at P_{max}	2.641994e+022	m^{-3}
Trapped electrons at Voc	2.664289e+022	m^{-3}
Trapped holes at Voc	3.746405e+022	m^{-3}
Free electrons at Voc	1.920216e+022	m^{-3}
Free holes at Voc	8.998036e+021	m^{-3}
V_{bi}	1.077564e+000	V

Optimised solar cell model view



- So the final efficiency of solar cell is : 5.0313%