

Supplementary Materials

Narrowband Near-Infrared Perovskite/Organic Photodetector: TCAD Numerical Simulation

Marwa S. Salem^{1,2}, Ahmed Shaker^{3*}, Amal H. Al-Bagawia⁴, Ghada Mohamed Aleid⁵, Mohamed S. Othman⁵, Mohammad T. Alshammari⁶ and Mostafa Fedawy^{7,8}

¹ Department of Computer Engineering, College of Computer Science and Engineering, University of Ha'il, Ha'il, Saudi Arabia; marwa_asu@yahoo.com

² Department of Electrical Communication and Electronics Systems Engineering, Faculty of Engineering, Modern Science and Arts University (MSA), Cairo, Egypt

³ Engineering Physics and Mathematics Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt; ahmed.shaker@eng.asu.edu.eg

⁴ Chemistry Department, Faculty of Science, University of Ha'il, Hail, KSA; a.albagawi@uoh.edu.sa

⁵ B.Sc. Department, Preparatory Year College, University of Ha'il, Hail, Saudi Arabia; g.aleid@uoh.edu.sa, mo.abdelkarim@uoh.edu.sa

⁶ Department of Computer Science and Information, Computer Science and Engineering College, University of Ha'il, Ha'il 55211, Saudi Arabia; m.alsagri@uoh.edu.sa

⁷ Electronics and Communications Department, Faculty of Engineering, Arab Academy for Science and Technology and Maritime Transport, Cairo, Egypt; m.fedawy@aast.edu

⁸ Center of Excellence in Nanotechnology, Arab Academy for Science and Technology and Maritime Transport, Cairo, Egypt.

*Corresponding Author: ahmed.shaker@eng.asu.edu.eg

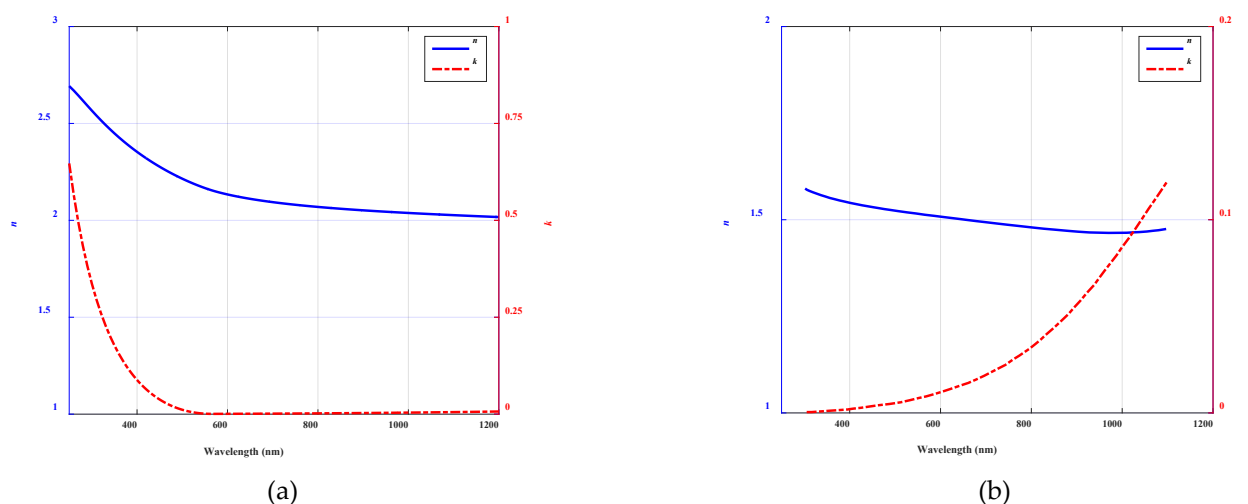


Figure S1. Optical constants (n and k) of (a) ITO and (b) PEDOT:PSS.

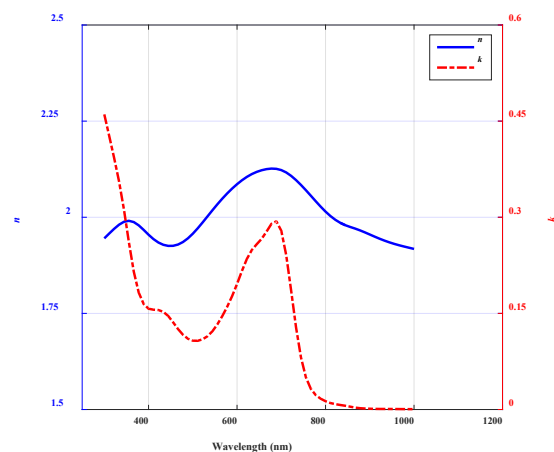
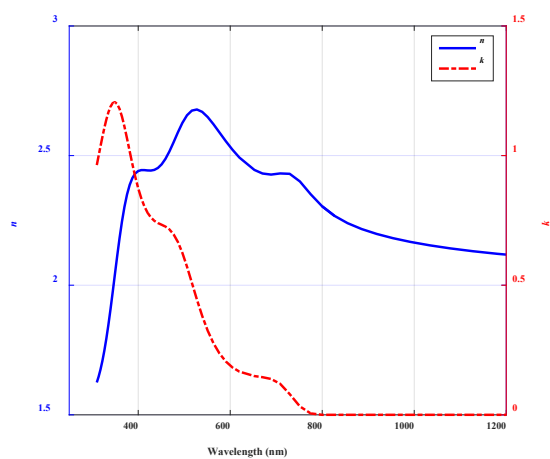
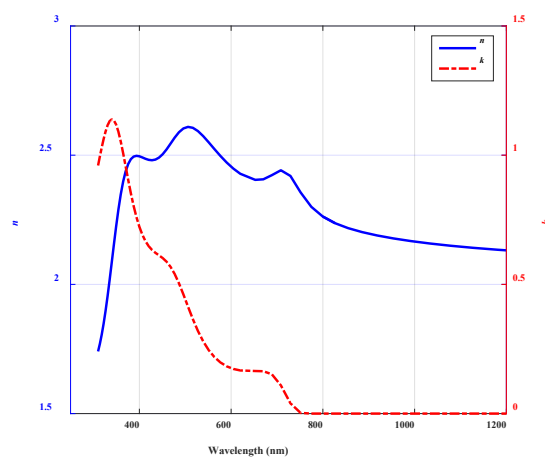


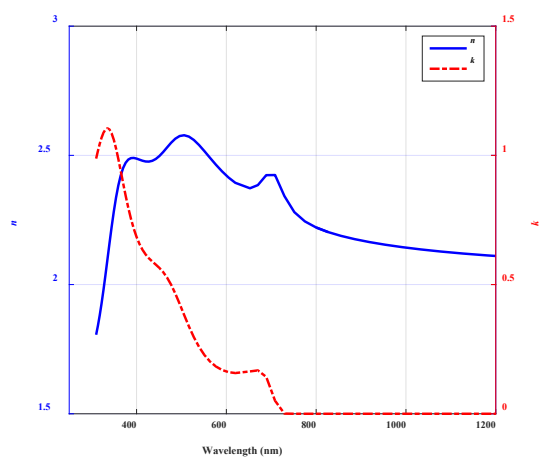
Figure S2. Optical constants (n and k) of organic blend PBDTTT-c:C60-PCBM.



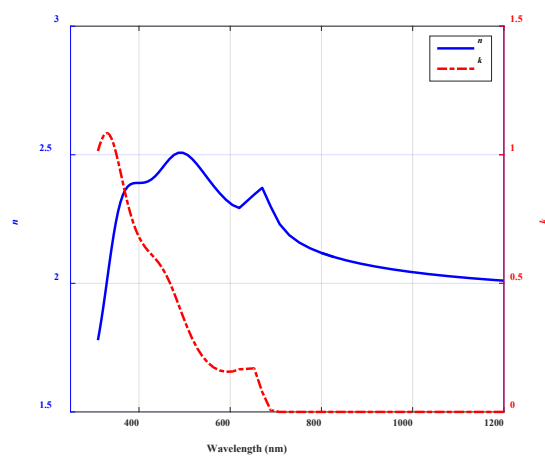
(a)



(b)



(c)



(d)

Figure S3. Optical constants (n and k) of $\text{Cs}_7\text{FA}_{1-y}\text{Pb}(\text{I}_x\text{Br}_{1-x})_3$ by Ellipsometric measurements for (a) $E_g = 1.62$ eV, (b) $E_g = 1.65$, (c) $E_g = 1.69$ eV and (d) $E_g = 1.8$ eV.

```

Deck
go atlas
#####
set t1 = 0.110
set t2 = $t1 + 0.500
set t3 = $t2 + 0.100
#####
mesh width=1e8
x.mesh loc=0.0 spac=0.5
x.mesh loc=1.0 spac=0.5
y.mesh loc=0.0 spac=0.0005
y.mesh loc=$t1 spac=0.0005
y.mesh loc=($t1+$t2)/2 spac=0.001
y.mesh loc=$t2 spac=0.0005
y.mesh loc=$t3 spac=0.001
#####
region num=1 name=ITO user.material=myITO y.min=0 y.max=$t1
region num=2 name=ABS user.material=myABS y.min=$t1 y.max=$t2
region num=3 name=HTL user.material=PEDOT y.min=$t2 y.max=$t3
#####
electrode num=1 name=cathode top
electrode num=2 name=anode bottom
doping num=1 n.type uniform conc=5e19
doping num=2 p.type uniform conc=1e15
doping num=3 p.type uniform conc=5e17
#####
#####
#ITO
material material=myITO user.group=semiconductor user.default=ITO
material material=myITO EG300=3.6 permittivity=9 affinity=4.2
material material=myITO NC300=2.2E+18 NV300=1.8E+19
material material=myITO MUN=100 MUP=25
material material=myITO index.file=myITO.nk
#####
#HTL
material material=PEDOT user.group=semiconductor user.default=CIGS
material material=PEDOT EG300=1.6 permittivity=3 affinity=3.3
material material=PEDOT NC300=2.2E+18 NV300=1.8E+19 MUN=5e-4 MUP=5e-4
material material=PEDOT index.file=myPEDOT.nk
#####
#ABS
material material=myABS user.group=semiconductor user.default=organic
material material=myABS EG300=1.45 permittivity=3.6 affinity=3.7
material material=myABS NC300=1e20 NV300=1e20 MUN=6e-4 MUP=1e-3
material material=myABS index.file=myABS.nk
#####
#Defects
trap region=2 e.level=0.290 donor density=2.7e16 degen=1 sign=5e-16 sigp=5e-16
trap region=2 midgap neutral density=2e14 degen=1 sign=1e-15 sigp=1e-15
#####
contact name=cathode workf=4.2
contact name=anode workf=4.3
#####
#models
models srh
#method
method newton maxtraps=10 dvmax=0.1
#beam
beam num=1 x.o=0.5 y.o=-0.1 wavelength=0.78 angle=90
# saves beam intensity to the log files
probe name=inten beam=1 intensity
solve init
solve vanode=0
#####
# Ramp wavelength from 0.4 to 1.2um under 30uW/cm2 illumination.
#####
log outf=organic_spec.log
solve bl=30e-6 beam=1 lambda=0.4 wstep=0.02 wfinal=1.2
#####
# Extract external quantum efficiency of each cell from the spectral file.
#####
extract init infile="organic_spec.log"
extract name="EQE" curve(elect."optical wavelength", i."cathode"/elect."source photo current") \
outf="EQE_ccs.log"

```

Figure S4. Silvaco Script used to calibrate the wide band Organic PD.