

Influences of mass Chlorophyll-a blends using P3HT:PCBM for efficiency of organic solar cells

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Abstract. Organic solar cells have been made using the material poly (3-hexylthiophene)(P3HT), [6, 6]-phenyl-C61-butyric acid methyl ester (PCBM), and Chlorophyll-a with blend methods. Active layer of P3HT:PCBM:Chlorophyll-a are deposited using spin coating with rotary speed of 2500 rpm for 10 seconds and subsequently heated at 100°C for 10 min. Mass of chlorophyll-a are 0.1 mg, 0.2 mg, and 0.3 mg. Thin layers are characterized by UV-Visible Spectrometer Lambda 25 for optical properties and Keithley 2602 for electrical properties. From the UV-Vis showed that absorbance of P3HT:PCBM:Chlorophyll-a are 400-614nm and 620-700 nm. Efficiency of P3HT:PCBM:Chlorophyll-a for mass chlorophyll 0.1 mg, 0.2 mg, and 0.3 mg are 2.68×10^{-2} %, 3.93×10^{-2} %, and 8.79×10^{-2} % respectively.

1. Introduction

Solar cells are devices whose can convert solar energy into electrical energy. Manufacture of semiconductor device using inorganic materials such as silicon, germanium. Efficiency of inorganic devices are very high, but the manufacture of the devices are very expensive. Wastes from the manufacture of inorganic devices can damage the environment. The researchers tried developing the device environmentally friendly and the cost of manufacture is also cheap. One of the materials developed are organic materials[1]. Organic solar cells (SSO) continue to be developed by mixing two types of semiconductor polymers that are known the bulk heterojunctions [2]. Researchers continue to improve efficiency of polymer solar cell based P3HT:PCBM with increasing electron and hole. Electron and hole formed from the exciton, of the process of excitation of active material when exposed to sunlight. Improved efficiency can be done to maximize the active material consisting of P3HT and PCBM with the widening of the active area, heating treatment, the use of solvents, and the addition of other materials[3]. Material P3HT and PCBM has a high absorption in the visible region in wavelength of 400-650nm[4]. Polymer solar cells based on P3HT: PCBM with the addition of polymethine dye has an efficiency of 0.08% - 0.11%[5]. Dye is an organic dye which is often used in the SSO as an absorber of sunlight. Chlorophyll is used as a dye has a high absorption in the wavelength of 600-700nm[6]. This study will be made of organic solar cells based on P3HT: PCBM: Chlorophyll with the structure of ITO / PEDOT: PSS / P3HT: PCBM: Chlorophyll /Al.

2. Experimental

Materials used are glass Indium Thin Oxide (ITO), HCl, aluminum, PEDOT: PSS, PCBM, P3HT, and chlorophyll. The tools used are glass beaker, Mettler Toledo AL204, Multimeters, Hot plate, and Evaporator. UV-Visible spectrometer Lambda 25 is used to determine the absorbance spectrum and



Keithley 2602A used to the I-V characteristics. P3HT, PCBM and chlorophyll are weighed using a digital balance with a variety mass of chlorohyll. PEDOT: PSS growth on the substrate ITO using a spin coating with rotary speed of 2500 rpm for 20 seconds and then heated at 100° C for 10 minutes. P3HT: PCBM: chlorophyll grown on the PEDOT : PSS layer using spin couter with a speed of 2,500 rpm for 20 seconds and heated at 100 °C for 10 minutes. Aluminum layer growth with evaporation on the layer of P3HT: PCBM: Chlorophyll.

Table 1. Mass of P3HT, PCBM, and Chlorophyll

chlorohyll	P3HT	PCBM
0.1 mg	13.33 mg	2.67 mg
0.2 mg	13.33 mg	2.67 mg
0.3 mg	13.33 mg	2.67 mg

3. Results and Discussion

3.1. Optical properties of Chlorophyll-a, P3HT, PCBM layer.

Absorption spectra of the Chlorophyll-a, P3HT, PCBM, P3HT:PCBM, and P3HT:PCBM:Chlorophyll-a are shows in Fig. 1. It is shown in this figure that absorption of Chlorophyll are 600-700 nm. The P3HT spectrum shows an absorption are 400-600 nm. The PCBM shows an absorption are 300-400nm. The P3HT blends PCBM shows absorption are 400-650 nm. Absorption of P3HT:PCBM:Chlorophyll-a are 400-700 nm. Absorption of P3HT:PCBM:Chlorophyll with variety of mass chlorophyll shows in Fig. 2. It is shows that the addition of mass chlorophyll can increase absorption and widening the range area of absorption.

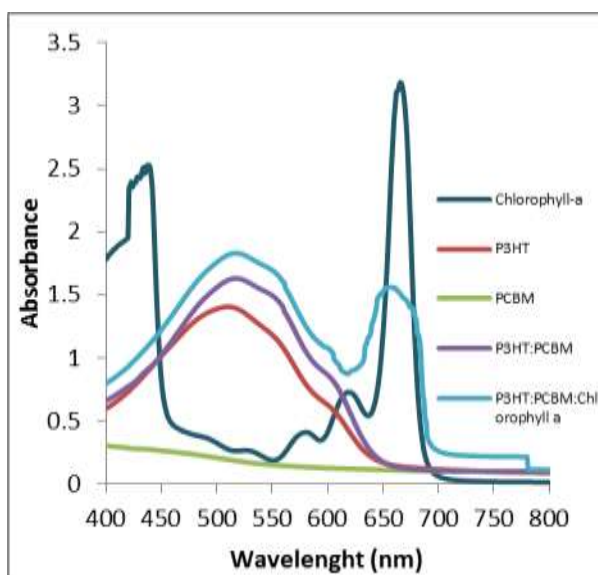


Figure 1. Spectrum Absorbance of Chlorophyll, P3HT, PCBM, P3HT:PCBM, P3HT:PCBM:Chlorophyll

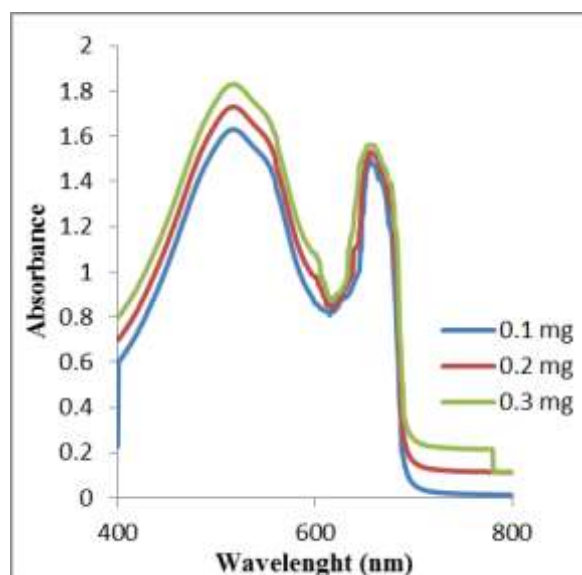


Figure 2. P3HT:PCBM:Chlorophyll with variety of mass chlorophyll-a are 0.1 mg, 0.2 mg, 0.3 mg

3.2. Electrical properties of the ITO/PEDOT:PSS/P3HT:PCBM:Chlorophyll-a/Al.

Current-voltage (I-V) characterization shows in Fig. 3. It shows that efficiency of mass chlorophyll 0.1 mg are $2.68 \times 10^{-2} \%$, 0.2mg are $3.93 \times 10^{-2} \%$, and 0.3mg are $8.79 \times 10^{-2} \%$. The addition of mass chlorophyll-a can increase efficiency, is due to the increase an electron and hole from excitons with the widening of area absorption. The results I-V characterization from Fig. 2 shows in table 1.

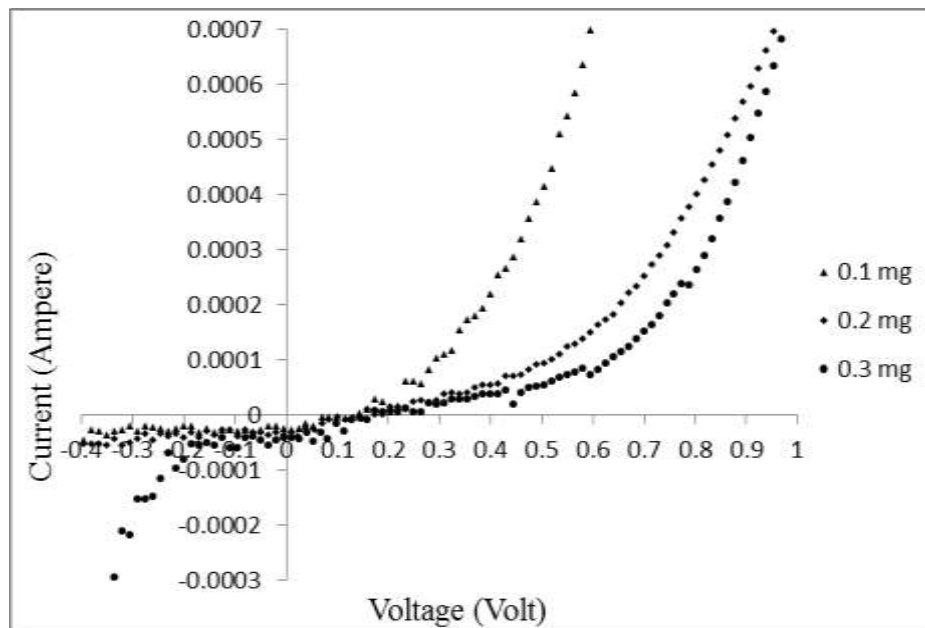


Figure 3. Curve I-V characterization P3HT: PCBM:Chlorophyll with mass of chlorophyll-a are 0.1 mg, 0.2 mg, 0.3 mg.

Table 1. Results of characterization P3HT:PCBM:Chlorophyll-a with variety of mass chlorophyll

Mass Chlorophyll	I_{sc} (ampere)	V_{oc} (volt)	I_{max} (ampere)	V_{max} (volt)	P_{max} (watt)	A (area) (m^2)	η ($\times 10^{-2} \%$)
0.1 mg	2.76×10^{-5}	0.13	1.94×10^{-5}	0.06	1.07×10^{-6}	4×10^{-6}	2.68
0.2 mg	3.15×10^{-5}	0.14	2.83×10^{-5}	0.06	1.57×10^{-6}	4×10^{-6}	3.93
0.3 mg	4.41×10^{-5}	0.16	4.34×10^{-5}	0.08	3.52×10^{-6}	4×10^{-6}	8.79

4. Conclusion

The addition of mass chlorophyll-a can increase efficiency, is due to the increase an electron and hole from excitons with the widening of area absorption. Chlorophyll-a can increase absorption spectra from 400-650 nm to 400-700 nm. Efficiency of mass chlorophyll 0.1 mg are $2.68 \times 10^{-2} \%$, 0.2 mg are $3.93 \times 10^{-2} \%$, and 0.3 mg are $8.79 \times 10^{-2} \%$.

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