Organic Solar Cells for Flexible, Colorful Applications

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Overview

In recent years, the development of organic photovoltaic devices has skyrocketed, opening the alternative energy field to solar generation beyond the restrictions of traditional silicon solar cells. Unlike silicon cells, organic solar cells can be tuned in color, transparency, and flexibility of material, broadening the application area and markets. Furthermore, their potential for low-cost fabrication using solution processing methods allows for large-scale applications. Recent efforts have been made to integrate solar energy generation into everyday products, such as roofs, windows, synthetic grass, polymers, and even clothing. In this work, we have studied the effects of solvent additives and post-processing treatments on the color and performance of P3HT:ICBA organic solar cells for their future large-area manufacturing.

Approach

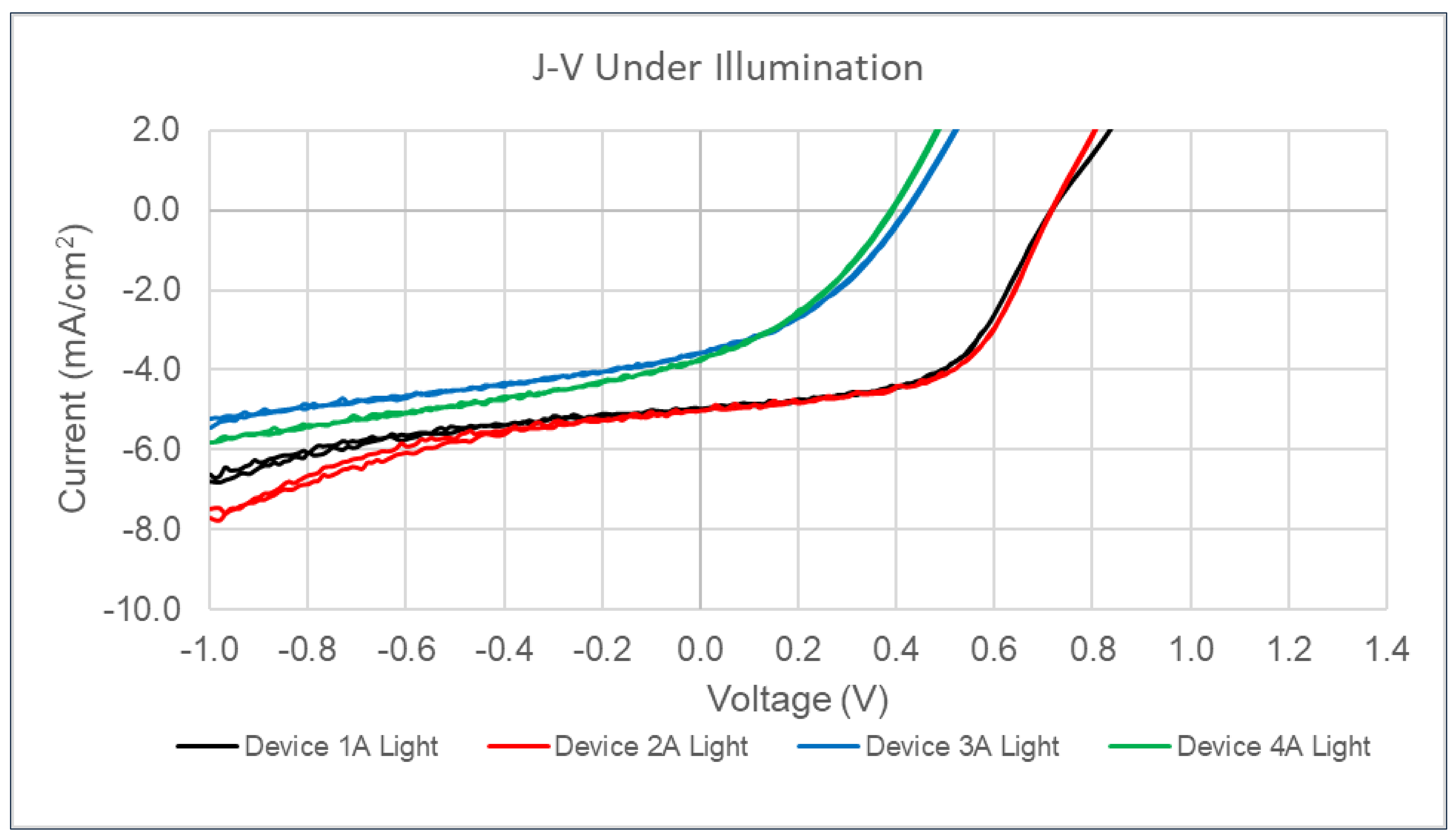
To test the effect of manipulating the crystallinity of the active layer, we added the solvent additive diiodooctane (DIO) to our active layer solution when manufacturing solar cell devices.

Gathered data from the solar simulator produces a J-V curve, which gives Voc, FF, and Jsc values to indicate performance.

Procedure

Static cast PEDOT onto substrate in spin coat vacuum → Anneal at 140°C for 20 minutes → Dynamic cast P3HT-ICBA solution with DIO additive → Deposit 100 nm Aluminum → Anneal at 120°C for 20 minutes

Results



Device	Treatment	Jsc (mA/cm^2)	Voc	FF	PCE (%)
1	Control 1	4.97 ± 0.11	0.71 ± 0.01	0.56 ± 0.01	1.98 ± 0.08
2	Control 2	5.03 ± 0.14	0.71 ± 0.00	0.56 ± 0.01	2.00 ± 0.07
3	DIO Additive 1	3.74 ± 0.14	0.40 ± 0.02	0.37 ± 0.01	0.56 ± 0.02
4	DIO Additive 2	3.70 ± 0.08	0.38 ± 0.01	0.36 ± 0.00	0.51 ± 0.02

Figure 1

Overall, the control cells produced higher values than the cells with the DIO additive. This indicates that the control cells are more efficient, and produce more power at a given voltage.

Results

Figure 2: Control device (left) and DIO additive device (right)

While the control P3HT:ICBA organic solar cells appeared orange toned, the solar cells with the DIO additive had a red-toned hue.

Discussion

Contrary to expectations, the devices with the DIO additive active layer were less efficient than the control devices. While this specific solution was less effective, more tests may be conducted to observe the effects of different additive solutions and concentrations.

The variance in color between the two devices demonstrates the tunability of organic solar cells. With progress, organic solar cells may be produced in a variety of colors to suit various building applications.

References

[1] W. Cao et al, ""Solar tree": Exploring new form factors of organic solar cells," Renewable Energy, vol. 72, pp. 134-139, 2014.

[2] W. Cao and J. Xue, "Recent progress in organic photovoltaics: device architecture and optical design," Energy & Environmental Science, vol. 7, (7), pp. 2123-2144, 2014.