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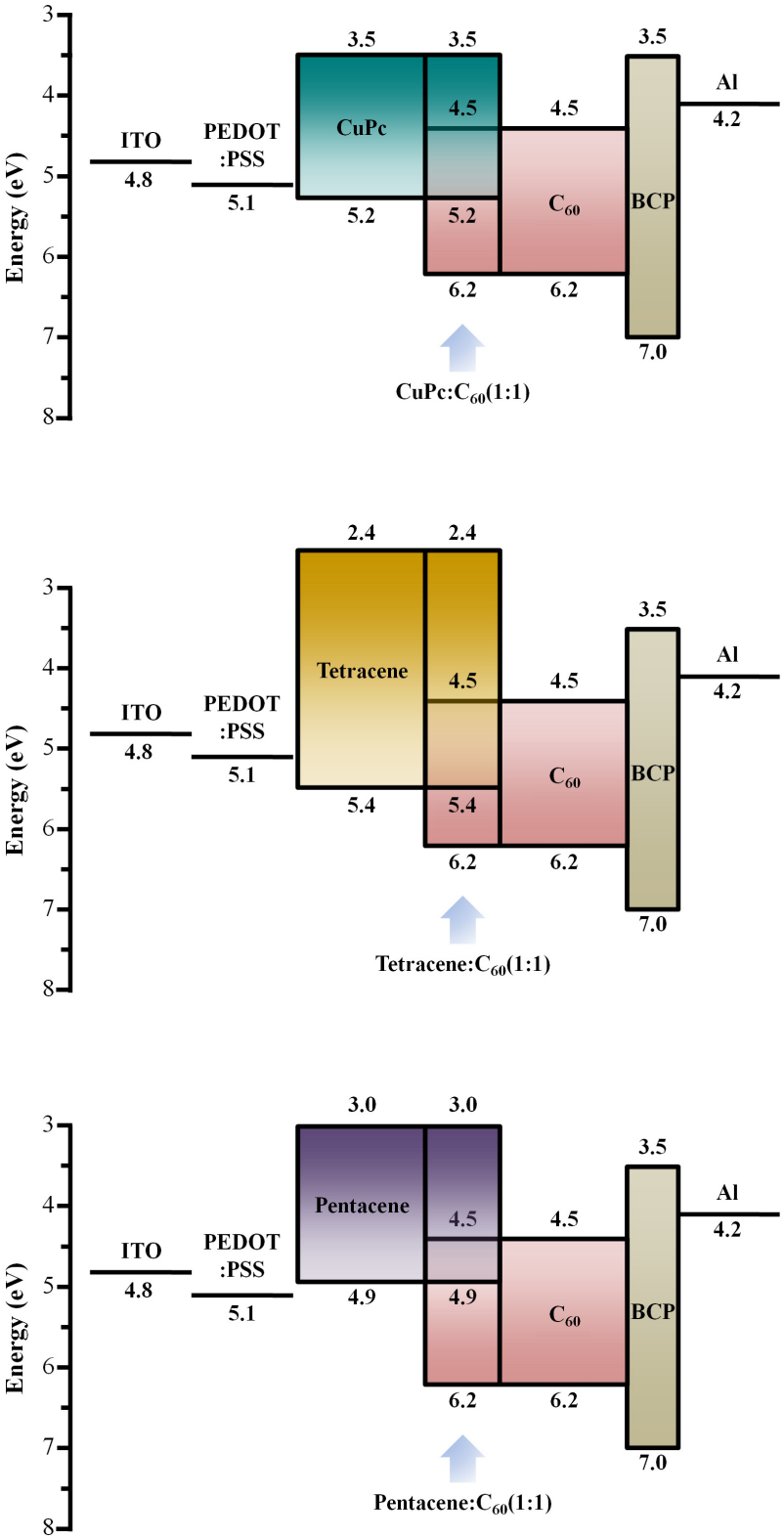
Performance Comparison of CuPc, Tetracene, Pentacene-based Photovoltaic Cells with PIN Structures

Jongwon Hwang, Yongsu Kang, Seonghui Park, Hyehyun Lee, Youngran Jo and Youngson Choe

Department of Chemical Engineering, Pusan National University

The fabricated photovoltaic cells based on PIN heterojunctions, in this study, have a structure of ITO/poly(3, 4-ethylenedioxythiophene)-poly(styrenesulfonate)(PEDOT:PSS)/donor/donor:C60(10nm)/C60(35nm)/2, 9-dimethyl-4, 7-diphenyl-1, 10-phenanthroline(8nm)/Al(100nm). The thicknesses of an active layer(donor:C60), an electron transport layer(C60), and hole/exciton blocking layer(BCP) were fixed in the organic photovoltaic cells. We investigated the performance characteristics of the PIN organic photovoltaic cells with copper phthalocyanine(CuPc), tetracene and pentacene as a hole transport layer. Discussion on the photovoltaic cells with CuPc, tetracene and pentacene as a hole transport layer is focussed on the dependency of the power conversion efficiency on the deposition rate and thickness of hole transport layer. The device performance characteristics are elucidated from open-circuit-voltage(Voc), short-circuit-current(Jsc), fill factor(FF), and power conversion efficiency(η). As the deposition rate of donor is reduced, the power conversion efficiency is enhanced by increased short-circuit-current(Jsc). The CuPc-based PIN photovoltaic cell has the limited dependency of power conversion efficiency on the thickness of hole transport layer because of relatively short exciton diffusion length. The photovoltaic cell using tetracene as a hole transport layer, which has relatively long diffusion length, has low efficiency. The maximum power conversion efficiencies of CuPc, tetracene, and pentacene-based photovoltaic cells with optimized deposition rate and thickness of hole transport layer have been achieved to 1.63%, 1.33% and 2.15%, respectively. The photovoltaic cell using pentacene as a hole transport layer showed the highest efficiency because of dramatically enhanced Jsc due to long diffusion length and strong thickness dependence.


Energy (eV)
3
4
5
6
7
8
ITO
4.8
PEDOT
:PSS
5.1
CuPc
3.5
5.2
4.5
3.5
5.2
C60
4.5
6.2
BCP
3.5
7.0
Al
4.2
CuPc:C60(1:1)
Tetracene
2.4
5.4
4.5
2.4
5.4
C60
4.5
6.2
BCP
3.5
7.0
Al
4.2
Tetracene:C60(1:1)
Pentacene
3.0
4.9
4.5
3.0
4.9
C60
4.5
6.2
BCP
3.5
7.0
Al
4.2
Pentacene:C60(1:1)