

Multi-Junction Organic Solar Cells

Introduction

Tools used: Solar Cell Utility, DiffractMOD, LaserMOD, MOST

In this application note, the listed tools are used to calculate the solar cell efficiency of multi-junction organic cells.

Structure Overview

This multi-junction solar cell consists of three organic cells, each consisting of copper phthalocyanine (CuPc) and 3,4,9,10-perylenetetracarboxylic bis-benzimidazole (PTCBI) region (the red and blue regions in Figure 1). The cells are separated by a thin silver layer that acts as a combination area for electrons. The Ag layers do not contribute greatly to the optical performance of the device, but are included here for completeness. Two layers are placed on the front of the device: a silicon dioxide (SiO_2) substrate layer and an indium tin oxide (ITO) layer. A silver layer is placed on the back of the device to act as a reflector.

The incident sunlight is a plane wave and launched from air into the bottom of the structure shown below in Figure 1.

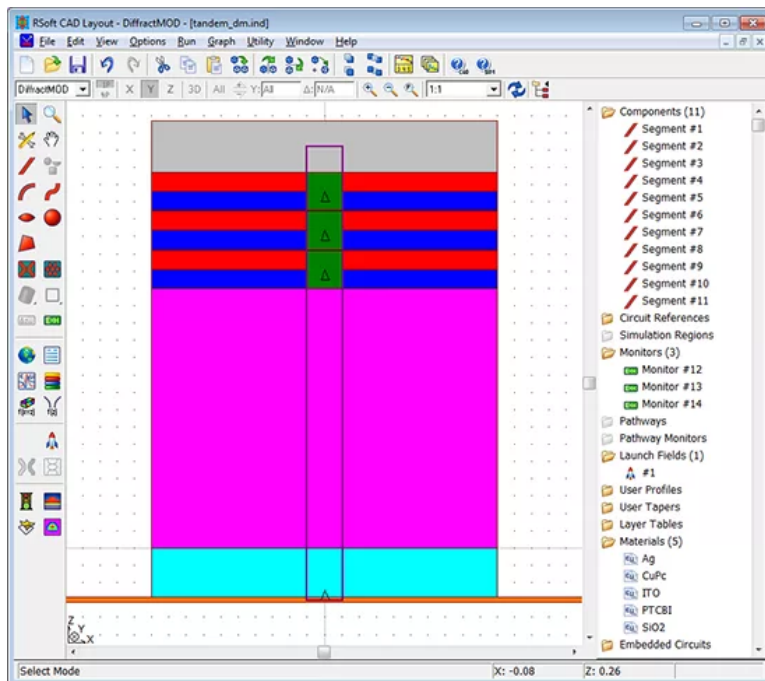


Figure 1. The multi-junction organic solar cell as seen in the RSoft CAD Environment interface. As drawn here, the light is incident from the bottom of the structure.

Computing Solar Cell Performance

The Solar Cell Efficiency can be easily computed using RSoft's **Solar Cell Utility**. Here, we use RSoft's **MOST** scanning tool to compute the Solar Cell Efficiency at three different incident light intensities; 10, 100, and 1000 (mW/cm^2).

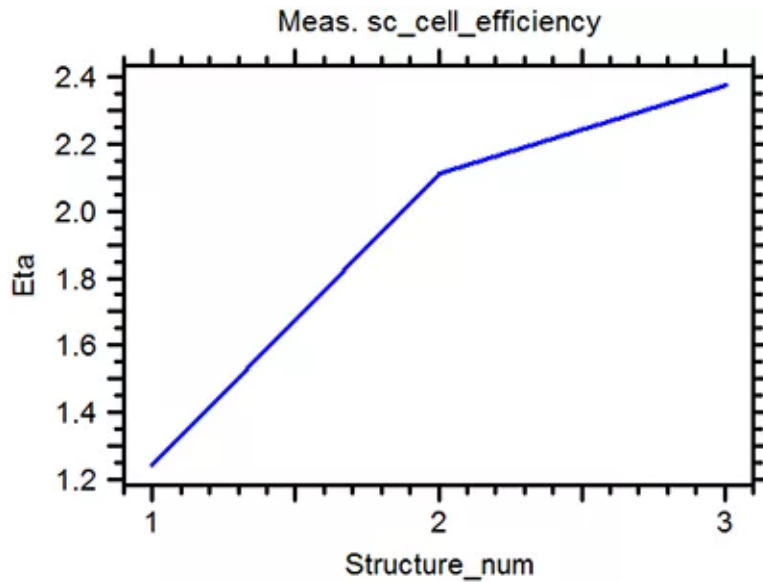


Figure 2. Solar Cell Efficiency (%) of the structure shown in Figure 1. This plot corresponds to Figure 3 in Ref [1]. An incident light intensity of (10,100,1000) [mW/cm^2] corresponds to Structure_num=(1,2,3).

Several settings used by the Solar Cell Utility in computing the Solar Cell Efficiency (%) include the Global Collection Efficiency, the Open Circuit Voltage, and the Filling Factor.

The Global Collection Efficiency (GCE) represents the efficiency at which generated electron-hole pairs are captured by the electrodes within the device. There are generally two methods to compute this quantity: 1) Perform a complete electronic simulation via RSoft's LaserMOD simulation tool, or 2) Fit the simulation results found with the Ideal Diode electronic model to experimental data. Here, we have used the Ideal Diode model utilizing the experimental data in Ref [1] to compute the GCE.

For this application note, the values for the Open Circuit Voltage and Filling Factor were obtained directly from Ref [1].

The Solar Cell Efficiency results at varying incident light intensities, as shown in Figure 2, agree well with Figure 3 in [1]. For a more detailed study of this structure, it would be necessary to use the LaserMOD electrical model.

References

- [1] A Yakimov, et al, "High photovoltage multiple-heterojunction organic solar cells incorporating interfacial metallic nanoclusters" Appl. Phys. Letters, 80 1667-1669 (2002)