Analysis of the Ideality Factor of a-Si:H Solar Cells

This paper analyzes the ideality factor of amorphous silicon (a-Si:H) solar cells as a function of both the thickness of the intrinsic layer and the applied voltage to the cells. The ideality factor in this work is extracted from the current/voltage characteristic that is calculated by solving the continuity and transport equations and taking into account the contributions of diffusion and drift currents for minority and majority carriers and, especially, the nonequality of mobilities and lifetimes of electrons and holes in a-Si:H solar cells. [DOI: 10.1115/1.4003294]

Keywords: ideality factor, amorphous silicon, modeling

1 Introduction

The ideality factor of a-Si:H solar cells can be simulated analytically or numerically. The analytical models demonstrate the dependence of solar cell operation on their physical parameters and they are much more suitable than numerical calculations to fit experimental data. However, analytical models have the drawback of requiring strong approximations, as in Ref. [1], where the light is assumed to be uniformly absorbed within the intrinsic (i)-layer, resulting in a poor approximation for the calculation of the complete current/voltage (J/V)-characteristics. Okamoto et al. [2] considered both diffusion and drift currents in modeling the J/V-characteristics numerically, losing the physical insight into the physical processes. This paper aims to analyze the ideality factor for different values of the applied voltage, and the intrinsic layer thickness. Section 4 includes the conclusions of this work.

2 Model

This model considers the intrinsic layer (i-layer) as the only active layer, where the electron/hole pairs contribute to the short-circuit current [5]. The main physical simplification assumed within the model is that the electric field $E$ within the i-layer is spatially uniform [5,6] as

$$|E| = \frac{|V - V_{bi}|}{W}$$

(1)