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Comparison and optimization of the performance of Si and GaAs solar cells

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Abstract

Designing solar cells involves optimizing the device makeup, such as the semiconductor layer thickness and the impurity doping concentration, as well as the device parameters, such as the minority-carrier lifetime, the minority-carrier diffusion coefficient, and the surface recombination velocity. Optimization of solar cell performance is normally carried out by varying the device makeup or a particular device parameters, and assuming the rest of the parameterrs are constant. These device parameters, nonetheless, are influenced by the device makeup and should not be considered as independent variables. We calculate the performance of Si and GaAs cells using device-makeup-dependent parameters determined from experimental observations or, if uncertainty arises, from physical judgement based on available information. Both n/p and p/n Si and GaAs optimized cell structures are suggested.

For the specific device parameters used, our calculations show conversion efficiencies of 18.75% and 26.8% for the optimized, without texturized surface, Si and GaAs cells, respectively, under one AM1.5 global normal sun condition. For concentrator cell applications, the optimized Si and GaAs cells can yield 22.5% and 30.2% efficiencies, respectively. Comparison of model predications and experimental data shows good agreement.

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> …Illumination level is taken to be the ratio between incident power and AM1.5 reference power (100 mW cm−2). am and bm are tabulated values obtained from solar irradiance and the dependence of the absorption coefficient on the illumination wavelength and H the base thickness [16,17,19]. The boundary condition at the junction (p+-n interface) introduces a concept of dynamic junction velocity Sf considered to be directly related to the flow of carrier through the junction.…

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