Highlights

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ABSTRACT

abstract

1. Introduction

The necessity for renewable energy sources to meet the growing global demand for sustainable and environmentally friendly energy alternatives has become apparent. Among the wide range of renewable energy sources, sunlight is the cleanest, safest, and most abundant source for use in sustainable energy for economic growth [1] [1]. The utilization of solar energy heavily depends on the use of photovoltaic cells, with silicon-based devices playing a critical role [?].

The issue of semiconductor purity has become increasingly significant since the advent of the transistor in 1947 [2] [2]. The 1960 study by Shockley and Queisser [3] [3] demonstrated that the electrical properties of n^+-p silicon diodes deteriorate when impurity atoms of metals such as Cu, Fe, Mn, Au, Zn, and Ni are present. This study prompted investigations focused on preventing contaminating metals from entering semiconductors during manufacturing. In particular, metallic impurities are known to reduce the efficiency of silicon-based devices through direct shunting [4] [7], increased leakage current [5] [6], or bulk recombination [6] [5]. Despite extensive study of metallic impurities in silicon over the past fifty years [[2] [2], [7] [4]], the problem continues to attract significant attention [?].

$\mathrm{cm}^{-3}\mathrm{Fe,tot}n$

Table 1
Parameters varied during the simulation

Parameter	Value
d_p, μm	$180 \div 380$
N_B, cm^{-3}	$10^{15} \div 10^{17}$
N_{Fe}, cm^{-3}	$10^{10} \div 10^{14}$
T, K	$290 \div 340$
Illumination	AM1.5G, 1000 W/m^2; 940 nm 5 W/m^2; 940 nm 10 W/m^2

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$$\epsilon A = \frac{A^{FeB} - A^{Fe}}{A^{FeB}} \times 100\% \quad (1)$$

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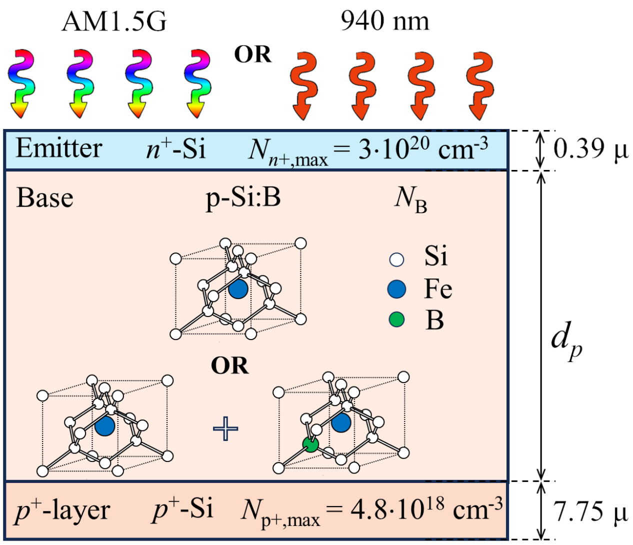

Figure 1: Schematic diagram of analyzed solar cells.

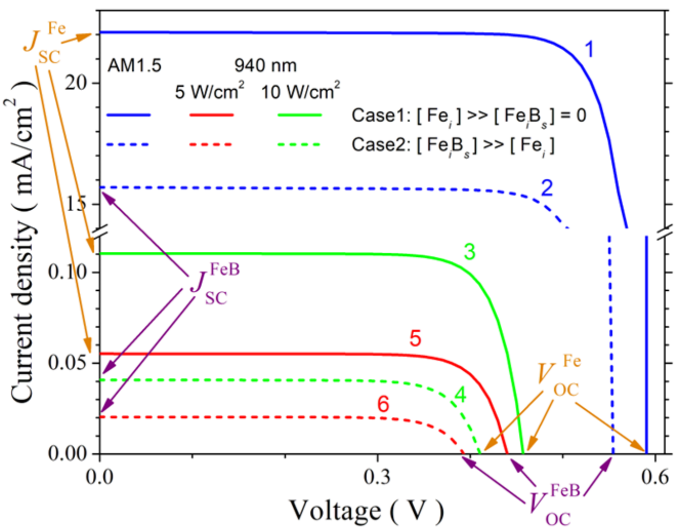

Figure 2: Typical IV characteristics, calculated for structure with $d_b = 180$ μ, $N_B = 10^{17}$ cm^{-3}, $N_{Fe} = 10^{14}$ cm^{-3} at T = 290 K. Illumination: AM1.5 (curves 1, 2), 940 nm 10 W cm^{-2} (3, 4) and 940 nm 5 W/cm^2 (5, 6). Solid and dotted lines correspond to Case 1 and Case 2, respectively.

2.

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