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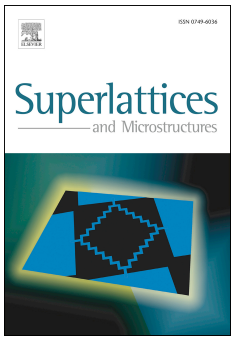

Model and optimal design of ^{147}Pm SiC-based betavoltaic cell

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Model and Optimal Design of ^{147}Pm SiC-based Betavoltaic Cell *

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Abstract

The method of Monte Carlo and numerical model co-simulation is adopted to research the radiation-voltaic effect in semiconductor device and used in the optimal design of ^{147}Pm SiC-based cell in this paper. According to the energy spectrum of ^{147}Pm, the ionization energy deposition in the cell is calculated by Monte Carlo method. The result is converted into the non-equilibrium carrier information and mapped into the device grid generated by the numerical software, so as to simulate output characteristics of the cell. The simulation results based on the SiC PIN betavoltaic cell show the conversion efficiency firstly goes up and then decreases as the I layer thickness increases, and the conversion efficiency decreases when the doping concentration of I layer increases. The conversion efficiency will be 3.74% when the doping concentration and thickness of I layer are 5×10^{14}cm^{-3} and 20μm respectively. According to the analysis, the recombination loss of radiation-induced carriers in I layer is the main factor influencing the improvement of conversion efficiency. To improve the conversion efficiency, the "graded N layer" SiC PN cell is proposed in this paper to replace conventional I layer with two N layers with different doping concentrations; the electric field is introduced to reduce the recombination loss of the radiation-induced carriers. The conversion efficiency will be 4.58% when the thickness of two layers are 10μm and the doping concentrations are respectively 5×10^{14}cm^{-3} and 1×10^{16}cm^{-3}.

Keywords: radiation-voltaic, betavoltaic cell, Monte Carlo, numerical simulation

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1 Introduction

In various types of micro-energy sources, the betavoltaic cell based on radiation-voltaic effect is regarded as the ideal long-term energy for MEMS system because its advantages i.e. high liability, high integration etc. The high output power is the prerequisite for the betavoltaic cell to be widely applied, however, due to reasons like self-absorption effect and cost of the isotopic source, it's difficult for the betavoltaic cell to improve the output power by improving the activity