

Public Abstract

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Title:MODELING AND MAXIMUM THEORETICAL EFFICIENCIES OF LINEARLY GRADED ALPHAVOLTAIC AND BETAVOLTAIC CELLS

This thesis presents a study on the optimization of the amount of energy deposited by alpha and beta particles in the depletion region of a silicon carbide (SiC) as al-phavoltaic and betavoltaic cells using Monte Carlo models.

Two Monte Carlo codes were used in this study for alpha particles: the Stopping and Range of Ions in Matter/ TRansport of Ions in Matter (SRIM/TRIM) code and the GEometry ANd Tracking simulation of the passage of particles through matter (GEANT4) code. The models examined the transport of 5.307 MeV alpha particles emitted by Polonium-210 (Po-210). Energy deposition in a 1 μm depletion region of SiC was calculated for a spherical geometry using GEANT4, and a slab geometry using both SRIM/TRIM and GEANT4. These geometries were optimized for the maximum possible al-phavoltaic energy efficiency. The models, which match very well, indicate that the maximum theoretical energy conversion efficiency, which was optimized for a SiC al-phavoltaic cell is approximately 2.1%.

Three Monte Carlo codes were used in the study for beta particles: the GEometry ANd Tracking simulation of the passage of particles through matter (GEANT4) code, the PENetration and Energy LOSS of Positrons and Electrons in matter (PENELOPE) code, and the Monte Carlo N-Particle eXtended (MCNPX) code. These codes were used to examine the transportation of beta particles from Yttrium-90 (Y-90), Strontium-90 (Sr-90), and Sulfur-35 (S-35). Both the average beta energy from each source and the entire spectrum were modeled for calculating maximum theoretical energy deposition in both a spherical and slab geometry. A simulated depletion region was added in post processing containing the maximum energy deposited per μm . The calculated maximum efficiencies are approximately 1.99 %, 0.31 %, and 0.02 % using mono-energetic average energy and 1.32 %, 0.21 %, and 0.02 % using an energy spectrum for S-35, Sr-90, and Y-90, respectively.

This study provides a useful guide for the upper limit of expected efficiency for al-phavoltaic and betavoltaic cells using a linearly graded semiconductor.