

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

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ABSTRACT

This thesis presents a study on the optimization of the energy deposited by alpha and beta particles in the depletion region of a silicon carbide as alphavoltaic and betavoltaic cells using Monte Carlo codes. Two Monte Carlo codes were used for alpha particles: SRIM/TRIM and GEANT4 codes. The models examined the transport of 5.307 MeV alpha particles emitted by Polonium-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 alphavoltaic energy efficiency. The models indicate that the maximum theoretical energy conversion efficiency is approximately 2.1%. Three Monte Carlo codes were used in the study for beta particles: GEANT4, PENELOPE, and MCNPX codes. These codes were used to examine the transportation of beta particles from Yttrium-90, Strontium-90, and Sulfur-35. Both the average beta energy from each source and the entire spectrum were modeled for calculating maximum theoretical energy deposition per μm in both a spherical and slab geometry. 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.