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A Method for Calculating PIN Alpha-voltaic Cell Operational Life from Modelling and Simulation Data.

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Nuclear batteries find applications in medical implants, sensor nodes, and are suited to deployment in extreme environments. Nuclear batteries made from alpha radiation sources offer the potential of higher energy density compared to beta-voltaic batteries. The mitigation of alpha particle damage to semiconductor charge collection structures remains a challenge, to extend the very short operational life of the alpha-voltaic battery. Degradation of carrier mobility in semiconductors occurs due to alpha irradiation induced deep defects, which reduce the carrier lifetime (τ). The degraded τ leads to the transducer failure, which reduces the operational life of the battery. In this study I_{sc} , V_{oc} and P_{max} of the PIN type GaN alpha-voltaic cells were simulated using Silvaco Atlas, a TCAD software, for different lengths of the PIN transducers I-region from $0.2\mu\text{m}$ to $2\mu\text{m}$, for τ from $1\text{e-}8$ to $1\text{e-}15\text{s}$. τ was employed as a surrogate for radiation defect density within the device. From plots of normalized P_{max} of each device, the alpha particle fluence, semiconductor damage constant, and typical crystalline GaN τ , the operational life of the optimum device was computed.

Academic or Professional Status

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