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Modelling and performance analysis of a GaN-based n/p junction betavoltaic cell

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Abstract: In this work, we optimized the performance of a gallium nitride (GaN)-based n/p junction betavoltaic cell irradiated by the radioisotope nickel-63 (Ni63). In particular, we developed a lab-made software starting from an analytical model that takes into account a set of fundamental physical parameters for the cell structure. The simulations reveal that, by using a Ni63 radioisotope source with a 25 mCi/cm² activity density emitting a flux of beta-particles with an average energy of 17.1 KeV, the cell performs a conversion efficiency (?) in excess of 26%, thus approaching the theoretical limit for a GaN-based device. The other electrical parameters of the cell, namely the short-circuit current density (Jsc), open-circuit voltage (Voc), and maximum electrical power density (Pmax) are 240 nA/cm², 2.87 V, and 660 nW/cm², respectively. The presented analysis can turn useful for understanding the theoretical background needed to better face GaN-based betavoltaic cell design problems.

Keywords : analytical modelling, Gallium nitride, betavoltaic cell, nickel-63 radioisotope, radioactivity density