***Project description***

**Betavoltaic batteries**

***Abderrahmane Belghachi***

***Benameur Amiri,***

***Ilyas Daouali***

***Abdelouahab Douha***

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Conversion of nuclear decay energy into electrical power attracted significant attention since the early 1900s. During last decades betavoltaic nuclear batteries have been the focus of intensive research work. Nuclear batteries are best candidates for a number of applications where long-life power sources or low energy consumption are required such as; space applications, pacemakers, microsystems, remote-sensors, etc. A betavoltaic cell consists mainly of beta particles radioactive source and a semiconducting material with a pn, pin or Schottky junction. The fundamental operating principle of a betavoltaic device is the interaction of beta particles with matter releasing a substantial number of electron-hole pairs. The role of pn junction is the establishment of a build-in electric field insuring the separation of generated free carriers, therefore creating usable electric output power. Several radioisotope substances have been investigated as betavoltaic sources, for instance; H-3, S-35, Ni-63, Kr-85, Y-90, Pm-147, etc. Among these sources, Ni-63 is the most promising choice because of its desirable qualities. Besides, of being pure beta source, Ni-63 has a long half-life (about 100 years), produces low energy beta particles, so minimizing radiation damage to semiconductor converter, and can be stopped within few micrometers traveling in solids. As for its abundance, Ni-63 is important in the classification of radioactive waste from nuclear power plants.

In a betavoltaic device, the radioactive source plays a very important role in the determination of the structure performance. Our team has undertaken a simulation work of an Ni-63 source and GaN as the semiconducting material, other materials are suggested for latter work. This work is conducted with a Turkish partner, though the collaboration is not yet official, we aim to simulate betavoltaic batteries tested experimentally by the group of betavoltaic at the Physics Department, Yildiz Technical University, Istanbul, Turkey. Several axes are developed by our team, some of them are suggested as Doctorate subjects:

1. The development of a code based on Monte Carlo technique to simulate the trajectory of the created beta particle from the source to its final rest (less than 0.5 eV). The history of each particle is recorded and the deposited energy is then calculated aiming to find the electron-hole pairs generation function. Electron-hole pairs generation phenomena is the result of ionization process.
2. The second part of the work consists of using the obtained electron-hole pairs generation function and add it to the semiconductor continuity equation to be solved for a pn junction. As a first step, an analytical model similar to that of a solar cell is used, but as a plan, we intend to use a confirmed software SOLCORE. (Doctorate)
3. Thirdly, in this stage, we are using GEANT 4, a well established software to validate our homemade Monte Carlo code results and to use it for a much more complicated structures and materials, including GaN compounds. Primary results are very encouraging. (Doctorate)