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Author: Mr. Tomasz Mis
Warsaw University of Technology (WUT), Poland, tomasz.a.mis@mailplus.pl

NUCLEAR BATTERIES AS POTENTIAL POWER SOURCE FOR FUTURE SPACECRAFT

Abstract

Nuclear batteries produce electric energy from the natural radioactive decay of various isotopes, without the requirement of nuclear fission. Electrical phenomena which forms the basis of the functioning of a nuclear battery had been described as early as in the works of Irene Joliot-Curie; nowadays, numerous works have exploited this subject, creating new versions and types of nuclear cells which vary in performance and potential use. The basic types of nuclear batteries/cells can be grouped into alphavoltaics (alpha radiation), betavoltaics (beta radiation) and γgamma-PV, or gamma-photovoltaics (gamma radiation). The last type relies on the conversion of the energy of the gamma decay into photons (visual or UV), which then feed the silicon photovoltaic cells. Alpha- and betavoltaics may - depending on the energy of the decay - function similarly, hovewer most of them relies either on a semiconductor effect or the electron excitation in substrate. γgamma-PV cells are also much less efficient than the corpuscular radiation cells. In the world's scale, a couple of companies already managed or are in the process of introducing nuclear batteries to the market (United States, Israel, Poland), with each company having its own technology of nuclear decay energy conversion. Most of the nuclear batteries already available or prepared for market launch are dedicated to small electronic devices, such as sensors, memory chips etc., however their performance is directly depending on the parameters of the isotope employed and the size of the cell. Their persistent advantage is the employment of a radioisotope which does not pose the risk of proliferation and is not (at least significantly) fissile - these aspects make a nuclear cell an attractive alternative to radioisotope thermal generators (RTGs), which usually incorporate self-heating isotopes of plutonium. Nuclear cells 'life' - period of efficient functioning - is directly dependant on the half-life of the isotope and may vary from months (polonium-210) up to hundreds of years (americium-241). If qualified for a space application, a nuclear battery may be used as either an additional power source for spacecraft orbiting planets before Jupiter or as an RTG-alternative power source for deep space / beyond-Jupiter missions. Long-lasting missions, such as the planned Interstellar Probe, required to transmit data from large distances and during a very long mission time, are prone to the significant loss of efficiency of the crucial elements of the RTGs - which is not the case for nuclear cells.