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DEPARTMENT OF MECHANICAL ENGINEERING

SEMINAR

To be held on Thursday, June 14, 2018, at 11:00
in the Seminar Room (#117) of the Mechanical Engineering Building (#55)
at the Campus of the Ben-Gurion University of the Negev

Experimental Study of Direct β-Radiation Conversion for Energy Harvesting

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The seminar is based on PhD thesis supervised by

Prof. Gal deBotton

Abstract:

In many of miniature devices a reliable long term power source is a major requirement for their autonomous operation. However, in fact, the life span and the dimensions of many of these devices are dictated by their power source. Development of such a reliable power source is one of the most challenging obstacles hindering the widespread usage of many miniature devices. Attempting to address this issue, the feasibility of direct energy-harvesting from a radionuclide source is experimentally investigated by application of a dedicated apparatus. Some radionuclides materials have long lives and extremely high energy-density which is not affected by ambient conditions, and therefore are promising alternative energy sources. The idea is to collect the beta particles emitting from the source and convert these into usable electrical energy without intermediate steps. An adjustable apparatus was designed and constructed, enabling to demonstrate, characterize and tune the rate of energy conversion under the constraints of small current (in the range of pA) and electric potential of up to 5000 V. At its heart is a pair of moveable parallel electrodes in which the beta-source is adhered to the positive one, and the emitted particles are collected on the opposite negative electrode. The energy conversion rate is controlled by adjusting the gap between the electrodes and the ultra-high resistance load circuit. Experimental setup, calibration curves and parametric study results are presented for a 15 mCi ^{63}Ni radioisotope. The highest measured steady-state energy harvesting efficiency was 13.2 %, obtained for carbon collector, 8mm gap, and 5 kV potential difference. The maximal volumetric power density was 55 nW/cm^3 obtained for carbon collector at a 2 mm gap. These results were found to be in good agreement with theoretical predictions.

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