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Temperature Dependence of Electrical Performance of Tritium Sourced Betavoltaic Cells

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ABSTRACT

There is an increasing need for devices that can be powered for extended periods of time where it is impossible for maintenance or replacement, such as pacemakers, long term space flight or undisturbed sensors for military use. Since 1971, most devices run off a Lithium-Iodide battery, which gives a high amount of power but could only last approximately 2 to 5 years, requiring frequent replacement. However, replacement is unnecessary for betavoltaic cells as they can last at least 20 years. Commercially available tritium betavoltaic cells provided by City Labs Inc. were tested at a temperature range of -50°C to 150°C without any degradation. In order to fully determine the effectiveness of a betavoltaic cell, the electrical performance needs to be evaluated in temperature cycles ranging from -30°C to 70°C. This was evaluated by plotting I-V curves of a betavoltaic and a photovoltaic cell at multiple temperatures and evaluating the short circuit current and open circuit voltage to determine maximum power to compare electrical performance. Evaluation determined that the maximum theoretical power of the betavoltaic decreased by half as temperature increased from -30°C to 70°C, suggesting that betavoltaic cells are not temperature resistant. However, due to the power output of these cells, this can be negligible, and betavoltaics are ideal to run in below freezing conditions, as well as being reliable to operate at night unlike photovoltaic cells.

KEYWORDS

Betavoltaics, Tritium Sourced, Temperature Dependence, Electrical Performance, Temperature effects