Promethium-147 betavoltaic battery model to power micro sensors

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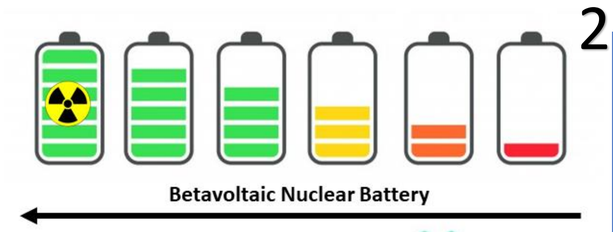
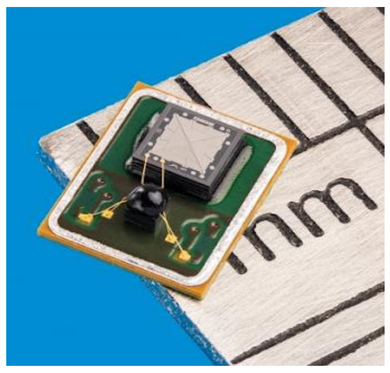


1 ***Nuclear batteries are devices that use radioactive decay to generate electricity.***

2 The focus is to provide reliable energy in environments where maintenance is complicated/impossible such as space exploration, oil extraction, and even in a hearth pacemaker.

3 Radioactive isotopes used in nuclear batteries have a half-life ranging from tens to hundreds of years, resulting in almost constant power.



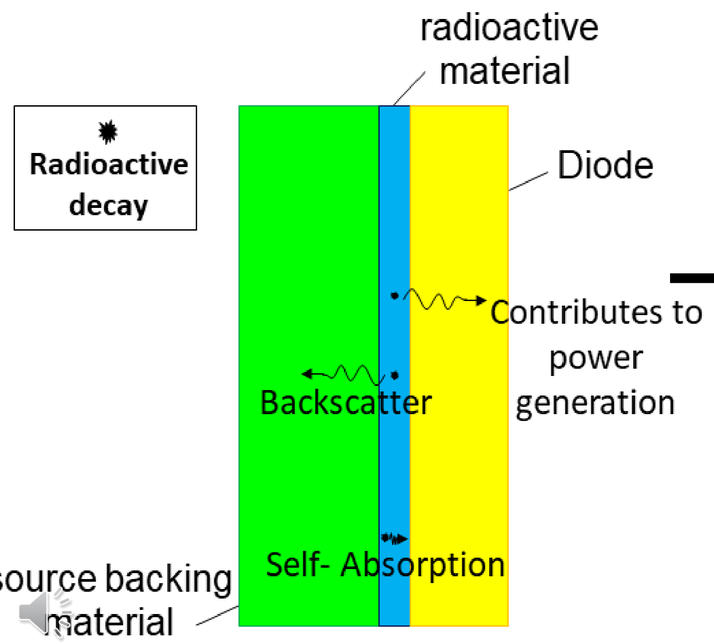
4 The power density of betavoltaic cells is significantly lower than that of their galvanic counterparts.

$$Pm^{147} \xrightarrow[2.6\ y\ \beta^-]{} Sm^{147} \xrightarrow[10^{11}\ y\ \alpha]{} Nd^{143}$$

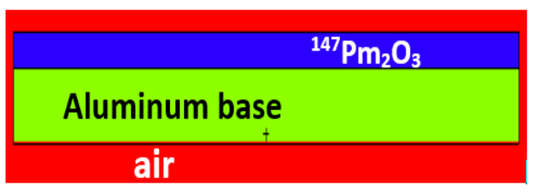
5 Microelectromechanical systems (MEMS) and semiconductor devices require short-term power supplies and long operating times

The objective of this work is to create an MCNP® routine to correlate the source thickness with particle number/deposited energy equilibrium.

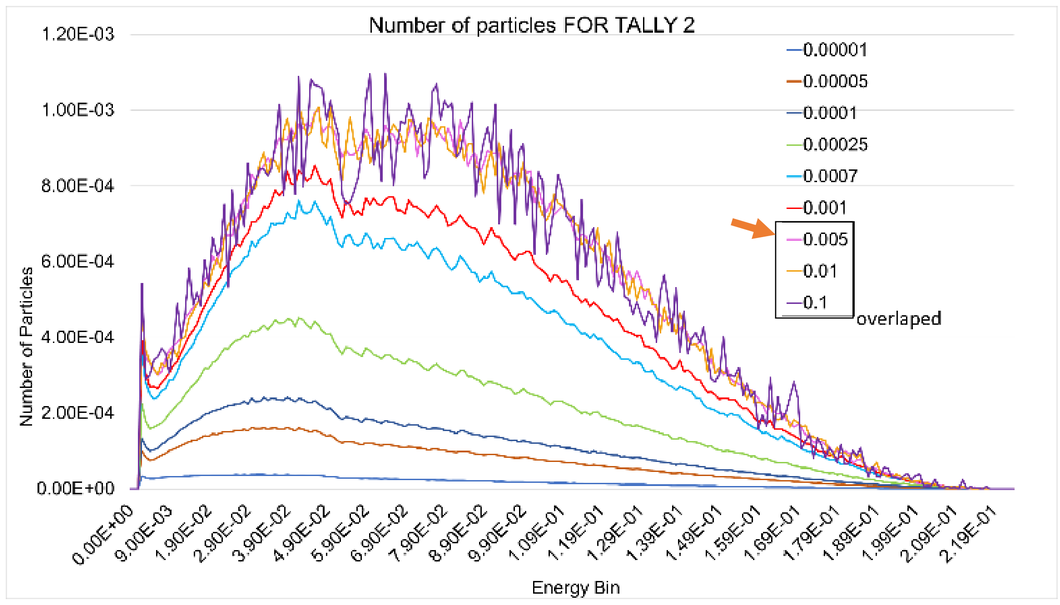
The more radioactive material is added, higher the source thickness will be. The thicker the source is, more beta particles will interact with the source material itself, thus not supplying these electrons to power generation.

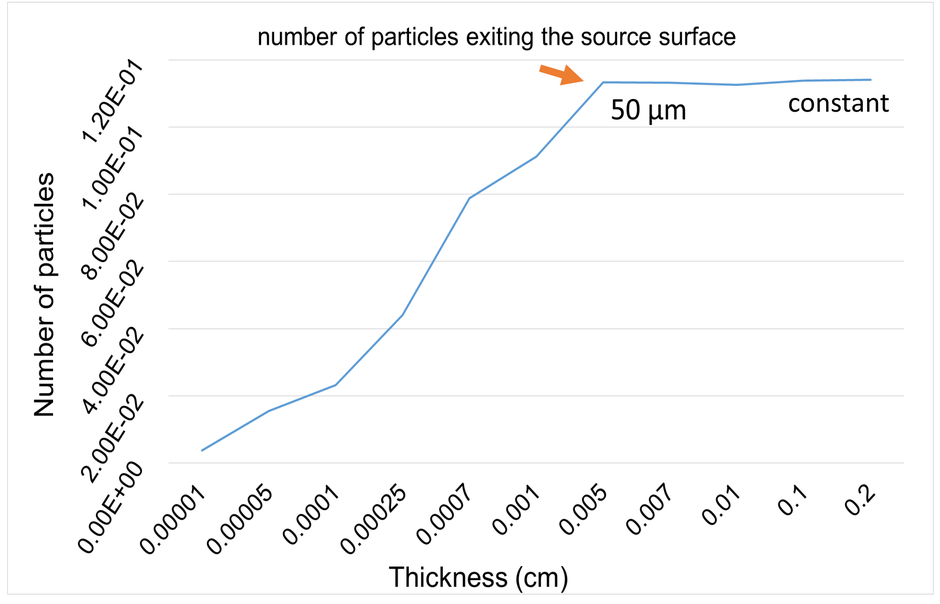


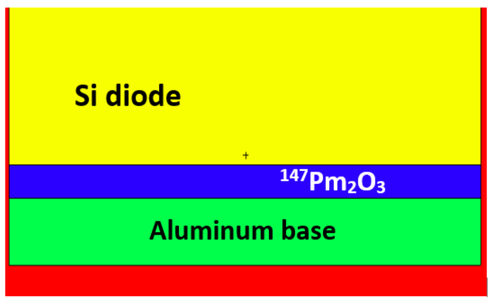
So, there is a maximum amount (thickness) that can be added due to self-absorption. Knowing this amount will allow posterior power estimates and correct prototype design.



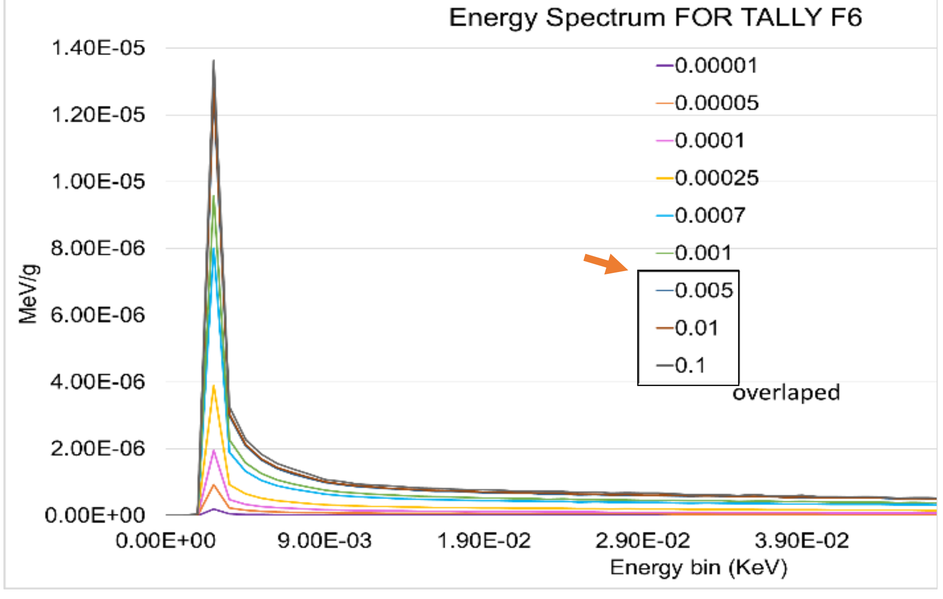
Geometry to measure the number of particles crossing the upper source surface

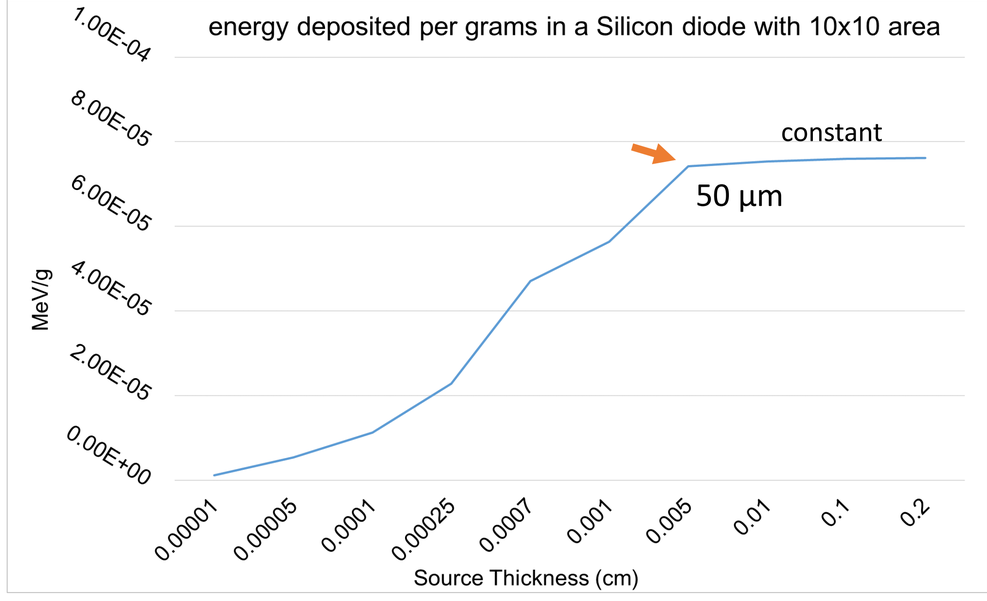






Geometry to measure the energy deposited in silicon





The results clearly show that the 0.005 cm source thickness will provide the most particles with the lesser amount of material and thus deposit more energy in silicon.

This preliminary test is important because it gives a real estimate of how much material will needed to be used to generate the largest final power output.