A Nuclear Microbattery for MEMS Devices

Track 8 – Basic Nuclear Engineering Advances

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ABSTRACT

Microelectromechanical Systems (MEMS) have not gained wide use because they lack the on-device power required by many important applications. Several forms of energy could be considered to supply this needed power (solar, fossil fuels, etc), but nuclear sources provide an intriguing option in terms of power density and lifetime. This paper describes several approaches for establishing the viability of nuclear sources for powering realistic MEMS devices. Isotopes currently being used include low-energy beta emitters (solid and liquid) and alpha emitters (solid). Several approaches are being explored for the production of MEMS power sources. The first concept is a junction-type battery. In this case, the charged particles emitted from the decay of the radioisotopes are absorbed by a semiconductor and dissipate most of their energy as ionization of the atoms in the solid. The carriers generated in this fashion are in excess of the number permitted by thermodynamic equilibrium and, if they diffuse to the vicinity of a rectifying junction, induce a voltage across the junction. The second concept involves a more direct use of the charged particles produced by the decay: the creation of a resonator by inducing movement due to attraction or repulsion resulting from the collection of charged particles. As the charge is collected, the deflection of a cantilever beam increases until it contacts a grounded element, thus discharging the beam and causing it to return to its original position. This process will repeat as long as the source is active. One final concept relies on temperature gradients produced by the sources, along with appropriate insulation, to create power using a Peltier device. The source is isolated in order to allow it to reach sufficient temperatures, and the temperature difference between the source and the rest of the device is exploited using the Peltier effect. Performance results will be provided for each of these concepts.