東京大学グローバルCOEプログラム　機械システム・イノベーション国際拠点

東京大学 THE UNIVERSITY OF TOKYO

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Nuclear Micro Power Generator

Ph.D Jae Wan Kwon

Assistant Professor
Department of Electrical and Computer Engineering,
University of Missouri - Columbia,
http://mems.missouri.edu/

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要旨

Weighty batteries have been significant obstacles to realizing the full potential of various miniaturized electrical and mechanical devices developed in the recent, remarkable growth of micro/nanotechnology. Micro electro mechanical systems (MEMS) devices have been developed for use as various sensors and actuators; as biomedical devices; as wireless communication systems; and as micro chemical analysis systems. The ability to employ these systems as portable, stand-alone devices in both normal and extreme environments depends, however, upon the development of power sources compatible with the MEMS technology. In the worst case, the power source is rapidly depleted and the system requires frequent recharge for continuous, long-life operation.

A significant amount of research has been devoted to the development of higher energy density, light weight power sources. For example, solar cells can be used to provide electrical power for MEMS. Micro fuel cells have also been developed for many applications and a micro combustion engine has been reported. One of the major disadvantages of using chemical-reaction-based power sources is that the power density of the fuels gets lower as the size of the systems is reduced. A second major challenge is that the performance of these systems drops significantly when they are designed to achieve longer lives. In such cases, refueling (or recharging) is not a viable option because it cannot be done easily in tiny, portable devices. And finally, the aforementioned power sources cannot be used in extreme environments because either the reaction rate is influenced by temperature, and/or there is no sunlight available for powering the device.

We have focused on nuclear materials (radioisotope sources), which can last very for extended periods of time and even in extreme environments. More importantly, because the energy change “per event” in radioactive decay is 10^4 to 10^6 times greater than that of a chemical reaction, the energy density (J/kg) of radioactive material is approximately 10^6 times greater than that of lithium ion batteries. It can use energy from radioactive decay emitting α or β particles, which are to be coupled to a rectifying junction. There’re various types of radioisotope battery technologies but all of those are struggling with very low efficiency. A liquid semiconductor-based radioisotope micro power source has been pioneerly developed. It has also shown very high overall efficiency. The semiconductor property of selenium was utilized along with a radioactive source of ^{35}S as elemental sulfur. Using a liquid semiconductor-based Schottky diode, electrical power was distinctively generated from the radioactive source.

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AIMD（先端知機能材料デバイスラボラトリーズ）
本件連絡先：　東京大学大学院工学系研究科 機械工学専攻　教授　鈴木 雄二
E-mail: ysuzuki@mesl.t.u-tokyo.ac.jp　Phone: 03-5841-6411
GCOE事務局　E-mail: gmsi-office@mechasys.jp　Phone: 03-5841-7437