Harvesting vibrations to power microsensors

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Battery replacement may soon be a thing of the past. Researchers from A*STAR's Institute of Microelectronics (IME) are tapping into low frequency vibrations, the most abundant and ubiquitous energy source in the surroundings, to power small-scale electronic devices indefinitely. IME's energy harvester has the ability to continuously convert the vibrations – across a wide frequency range in different environments - into electricity. This breakthrough presents a green, economical and sustainable long-term solution to eliminate the manual re-charging or replacement of power sources in miniature devices.

To use low frequency vibrations efficiently, common attempts focus on expanding the size of the device in order to attain maximum power output, which limit the applications of these energy harvesters. In addition, most reported designs can only operate at one fixed frequency, which significantly reduces the power generation efficiency in practical environments.

To address these design challenges, IME researchers have demonstrated an aluminium nitride (AlN) based energy harvester with record-high power density of 1.5 x 10-3 W/cm^3 capable of generating electricity equivalent to three commercial implantable batteries over a 10-year period. As an inexorable power supply, the remarkable power density feature translates into massive savings as costs and logistics associated with power source servicing will no longer be relevant.

The energy harvester also extends the flexibility of low frequency vibrational sources that can be harvested by offering the widest sampling range of 10th – 100 Hz. The wide sampling range makes it now possible to more productively harness real-world vibrational sources in spite of their irregularity and randomness.

Dr Alex Gu, Technical Director of IME's Sensors and Actuators Microsystems Programme, who conceptualized the energy harvester design, commented, "Our design strategy exploits the coupling effect between the Vortex shedding and Helmholtz resonating in order to enhance the Helmholtz resonating and lower the threshold input pressure. By transferring the low frequency input vibrational energy into a pressurised fluid, the fluid synchronizes the random input vibrations into pre-defined resonance frequencies, thus enabling the full utilization of vibrations from the complete low frequency spectrum."

Professor Dim-Lee Kwong, Executive Director of IME, said, "This breakthrough presents tremendous opportunities to realise a practical, sustainable and efficient energy renewal model with attractive small-form factor, low cost solution for a wide range of applications from implantable medical devices, wireless communication and sensor networks, to other mobile electronics that enable future mobile society."

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