MEMS-Based Pyroelectric Thermal Energy Scavenger

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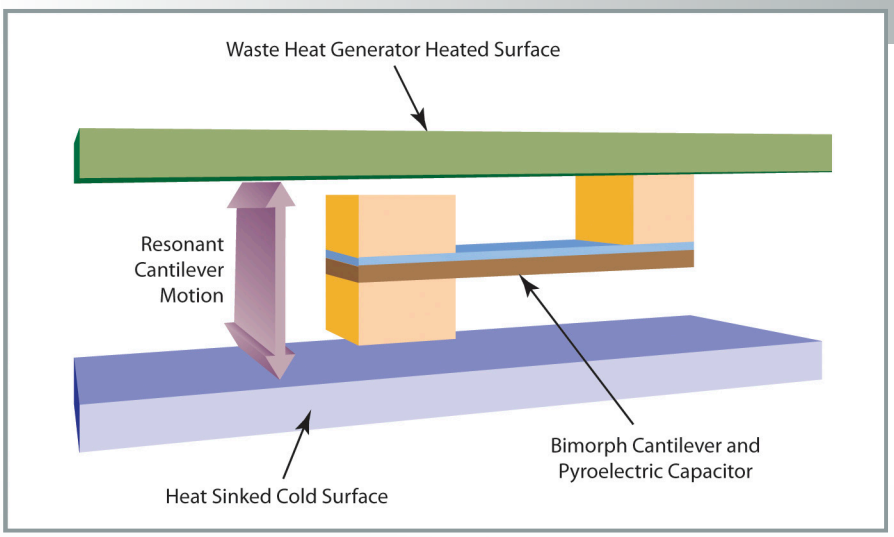

Technology Summary

A new type of microelectromechanical system (MEMS) high efficiency heat energy converter, or scavenger, was invented by ORNL researchers. This device is based on temperature cycled cantilevered pyroelectric capacitors. The scavenger converts thermal waste heat to electricity that can be used to monitor sensor systems, or recycled to provide electrical power while simultaneously reducing thermal cooling requirements. Given the current state of global industry, which discharges over 100 terajoules annually of low-grade waste heat, this technology could save industrial sectors tens of millions of dollars while also reducing greenhouse gas emissions.

In contrast to previous attempts to use temperature cycled pyroelectric materials as thermal energy harvesters, this invention can generate high rates of temperature change during the energy generation cycle with minimal power loss, leading to very efficient power generation. The device uses the heat source to thermally activate a bimorph structure and power temperature cycling through the converter. The overall energy conversion efficiency values are calculated to be several times larger than those achievable with any other competing thermal-to-electrical scavenging techniques.

The thermal energy conversion devices of this invention can be arranged into arrays sized for the heat source. The fabrication of these arrays can even be scaled to meet the needs of high volume, low cost manufacturing.

Advantages

- Potentially several times more efficient than other techniques for thermal to electrical energy conversion
- Operates at higher frequencies, leading to higher peak and average power generation
- Uses thinner film structures with lower thermal masses, comparatively higher dielectric strengths, and higher thermal conductivities
- No power loss due to temperature cycling
- Scalable energy conversion devices from single millimeter sized units to several centimeters in size
- High volume low cost manufacturing using standard CMOS and MEMS fabrication techniques

Potential Applications

- Active heat sinks and thermal management of high end computer microprocessors
- Improved efficiency and reduced cooling costs of concentrated photovoltaic solar cells
- Electrical power generation from hot automotive exhaust gases
- Electrical energy recovery from commercial and residential HVAC and heating units
- Energy scavenging from any source that produces waste thermal heat

Patent

Application in preparation

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