Electrical Energy Harvesting From Body Heat: Indirect Conversion Via Mechanical Vibration

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Abstract

Recent rapid progress in MEMS with wireless communication system has enabled low power micro sensor network for human body, Body Area Sensor Network (BASN). The information gathering from BASNs will provide a significant opportunities for various medical applications. One of the key factors required for the successful implementation of BASNs is to secure a reliable energy source able to provide enough power without a need for recharging or replacing battery. One promising reliable energy source is temperature difference between human body and ambient. A possible way is non-direct conversion by mechanical vibration of a bi-stable MEMS bi-morph beam by temperature gradient as a link mechanism between temperature gradient and electrical energy.
This paper characterizes the response of the bi-stable MEMS bi-morph beam based on the temperature changes from heat transfer through thermal contact. This energy conversion mechanism can be simulated by solving thermal contact problem and thermal buckling problem at the same time. Through the Linear Buckling study in Solid Mechanics module, the required static temperature load and residual stress for the buckling can be simulated.
To simulate the dynamic response, time dependent thermal contact resistance problem has been solved. The temperature distribution on the bi-morph beam can be estimated by Heat Transfer physics with Thermal Contact. And, the amount of thermal expansion of each layer of beam can be calculated by Thermal Expansion physics in Multiphysics. Based on the difference in expansion on the bi-morph materials, the stress or bending moment and the motion of beam can be determined by Solid Mechanics.
The estimated output power of proposed structure is about 0.3 mW/cm^2 with 10 degrees of temperature difference. Therefore, for a credit card size of arrayed system, we expect that over 10 mW of power which is enough to operate typical BASN can be generated. The result demonstrated possibility to harvest electrical energy from heat energy of a human body through the proposed thermo-mechanical-electric energy harvester.

Figures used in the abstract

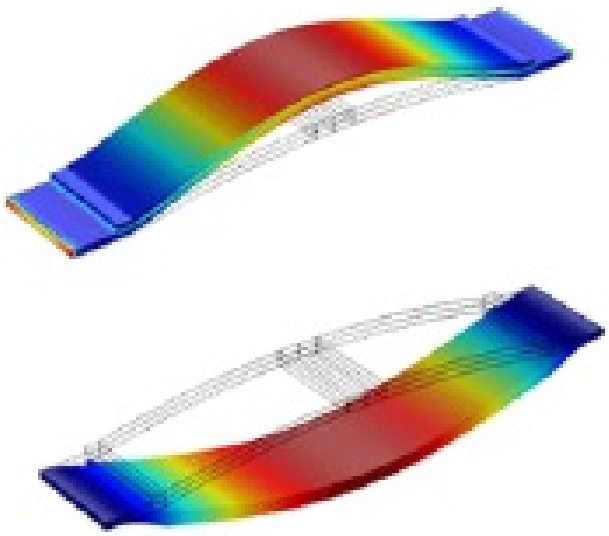

Figure 1: Fig.1 Buckling shapes of bi-stable beam.