Apparatuses for energy harvesting and energy transfer

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Energy harvesters are devices that convert energy from an external source and convert into usable energy. Most energy harvesters rely upon resonance. The latter often occurs at a fundamental natural frequency. However, deviating from the natural frequency in an oscillator exhibiting linear behavior often results in a steep drop in output energy approaching zero.

[This invention](#) describes a novel aeroelastic energy harvester that behaves nonlinearly. This allows for a broader operational frequency range and an improved efficiency over existing energy harvesters. Additionally, an apparatus for mechanoelectrically harvesting energy from an externally applied vibration comprises a flexible structure of piezoelectric material, which is configured to generate an electrical charge in response to the deflection.

Near-field wireless energy transfer (WET) allows the receiving of energy without a physical link to a power source. It can be especially advantageous for powering applications where the energy-storage capacities of batteries are limited, or insufficient and interconnecting wires are inconvenient/dangerous/not possible. Current industrial use of short distance WET technology suffers from drawbacks such as safety concern and the need to ground the receiver (capacitor-based WET), poor scaling to the microscale, self-induction, and Joule heating energy loss (induction-based WET) and poor overall efficiency (acoustic-based WET). Magnetoelectric effect (ME) is often utilized to alleviate shortcomings of near-field WET technologies. In existing magnetic field generators, the larger the desired magnetic field, the larger the generator or transformer that is needed. Also, micro- and nanoscale applications tend to waste significant electrical energy, making them impractical for the generation of magnetic fields.

[This invention](#) describes an apparatus for near-field wireless energy transfer. A first layer provides or comprises a piezoelectric phase or a material with or adapted for electromechanical coupling; and a second layer provides or comprises a magnetostrictive phase or a material with or adapted for a magnetomechanical coupling. The second layer is mechanically and/or chemically coupled to the first layer to provide a composite structure. The ring structure can produce a uniform AC magnetic field from a low-power AC voltage in the presence of a DC magnetic field; the outer surface of the electrode is grounded.

ADVANTAGES

- Broader operational frequency range, improved efficiency, flexible structure [Energy harvester]
- Suitability for nano- and microscale applications; capability to work independently of size, low-power and a wide-band frequency output [WET]

APPLICATIONS

- Energy, networking, virtually any industry [Energy harvester]
- Medical instrumentation (e.g., Active implanted medical devices such as pacemakers); vehicle-to-vehicle and vehicle-to-grid charging; electric motors, electricity distribution and generation (transformers), wireless power transfer, antennas, computer memory, electronics, wireless power transfer (automotive and consumer electronics) [WET]

PUBLICATIONS

- U.S. Patent Application No. 17/456,495 – entitled "Low-power high-frequency directional tunable AC magnetic field" (Notice of Allowance mailed November 4, 2022), and
- Pending U.S. Provisional Patent Application
- [Research Publications List](#)

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