Energy Harvesting and Magnetic Field Sensing with Bidomain $LiNbO_3$-Based Composites

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With the recent thriving of low-power electronic microdevices and sensors, the development of components capable of scavenging environmental energy has become imperative. We have developed a laminar composite based on bidomain LiNbO3 (b-LN) / metglas. This low-frequency, lead-free, and high-temperature MME system can scavenge power simultaneously from both low-level ambient vibration and magnetic field sources. With an appropriate storage circuit, it should thus be able to support ultralow-power electronic components. Due to its very large voltage transduction ratio, an attractive option could be a self-powered sensor used simultaneously as a vibration / magnetic sensor and a power generator when inactive.

At the same time, b-LN metglas composites can detect low magnetic fields at room temperature with a record value of sensitivity to the magnetic field as low as 200 fT at a frequency of ca. 7 kHz. Furthermore, ME tuning-fork-shaped composite structure based on a b-LN / metglas has shown a sensitivity down to 3 pT under real-life conditions at a low resonance frequency of ca. 300 Hz.

Importantly, the lead-free nature of LN meets the demands of the RoHS directive which assumes the restriction of the use of certain hazardous substances in electrical and electronic equipment. Thus, applications based on LN can substitute commonly used PZT ceramics. The b-LN crystals demonstrated excellent properties in the application of magnetoelectric magnetic sensors, vibration sensors, energy harvesters, actuators, position and magnetic field sensors.

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