

Piezoceramic materials for vibrational energy harvesting

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Abstract:

Energy harvesting is a field of research that has attracted increasing interest for more than a decade. It can be defined as the technology of devices that transform low-grade energy such as solar energy, vibrations, thermal energy and weak electromagnetic fields into usable electrical energy. Energy harvesting is a key enabling technology for modern wireless sensors where avoiding a battery is either crucial or gives an important competitive edge. In the case of wireless monitoring systems for industrial systems, battery-less sensor nodes will keep the maintenance costs at a minimum. Other examples are implantable devices and sensors built directly into a closed structure such as the fuselage of an aircraft.

The present work deals with vibrational energy harvesting where the input energy is kinetic (acceleration or strain) and the focus will be on piezoelectric ceramic materials. A number of different ceramic technologies will be compared – thick films integrated with MEMS (microelectromechanical systems), tape casting and conventional bulk ceramics – and relevant generator designs will be considered in each case. When it comes to choosing a suitable piezoceramic material, a number of functional properties need to be taken into account and these are conventionally combined into a single figure-of-merit, depending on the relevant operation mode. This concept will be used here to compare a number of piezoceramic materials, including various types of doped PZT (lead zirconate titanate) and some lead-free compositions.

The performance of a number of energy harvesting generators manufactured by this research group will be summarised in terms of open-circuit voltage and output power as a function of excitation frequency and amplitude, and a comparison with results from the literature will be given.