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Piezoelectric MEMS vibrational energy harvesters: advances and outlook

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Abstract

Piezoelectric MEMS energy harvesters based on thin films are compact and cost-effective microgenerators for scavenging environmental vibrations. This technology is promising for the replacement of electrochemical batteries in low power autonomous sensors and microdevices capturing vibrations in the μW-mW range. Most of piezoelectric MEMS devices, reported in the last few years, exhibit low generated power/voltage and are not suitable for practical applications. This work reviews the current status of MEMS energy harvesters based on piezoelectric thin films, highlighting approaches/strategies to face the two main challenges to be addressed for high performance devices, namely generated power and frequency bandwidth. The paper introduces the theoretical principles and the main figures of merit of energy conversion in piezoelectric thin films and devices. After an overview on piezoelectric thin films for energy harvesting applications, highlighting their key properties, the manuscript reports a comprehensive survey on the state of the art for this device technology. The last section summarizes the review, highlighting key issues to be addressed and providing an insight into the future outlook to realize devices for practical applications.

Keywords: Energy harvesting, piezoelectric thin films, MEMS

Introduction

The advances in large scale integration design and device size down scaling have enabled a strong decrease in power consumption of electronics and the realization of ultralow power integrated circuits operating with power as low as tens of nWs. This scaling trend has stimulated the research and development of autonomous sensors and network systems integrating onboard power sources scavenging available ambient energy. The ultimate goal is the realization of compact, high performance mechanical harvesters to be integrated with sensors, electronics and a transceiver on a single chip.

These energy harvesters could replace the electrochemical batteries or complex wiring for powering microsystems and overcome issues related to their employment, including toxicity, periodic