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A MEMS Piezoelectric Vibration Energy Harvesting Device

Marcin Marzencki[1], Skandar Basrour[1], Benoît Charlot[1], Serge Spirkovich[2], Mikael Colin[2]

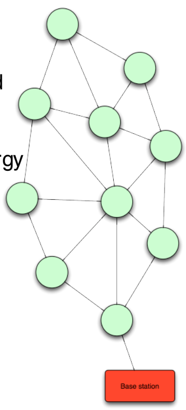
[1]TIMA laboratory, 46 Avenue Felix VIALLET, 38031 Grenoble, France.
[2]MEMSCAP SA, Parc Technologique des Fontaines, ZI Bernin, 38 926 Crolles, France.

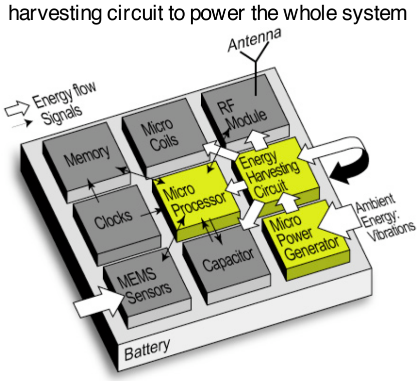
This poster presents a ***MEMS micro power generator*** *to be used as a power source for a* ***wireless sensor node****. The device scavenges* ***environmental mechanical vibrations*** *and converts it into electrical energy through a* ***piezoelectric*** *transduction.*

Wireless sensor node

A wireless sensor network module is being developed at TIMA laboratory, it contains :

- An asynchronous ultra low power processor
- A RF transceiver compliant with IEEE standard
- MEMS sensors
- A Li-ion thin film micro battery
- A micro power generator and its dedicated energy harvesting circuit to power the whole system

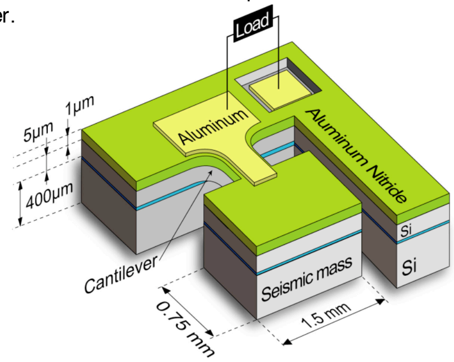




One of the main problems for these microsystems is the power source. For the moment, most of them use a non rechargeable battery, characterised by a finite amount of stored energy, an important volume and mass that dominates the entire system.

Vibration harvesting device

The micro power generator, is composed of a seismic mass made of silicon connected to the substrate by a rounded shape cantilever. The cantilever is composed of monocristalline silicon (5μm), acting both as a mechanical support and bottom electrode, an aluminium nitride piezoelectric layer (1μm) and an aluminium upper electrode. The device fits into a 2mmx2mm square of a silicon on insulator (SOI) wafer.

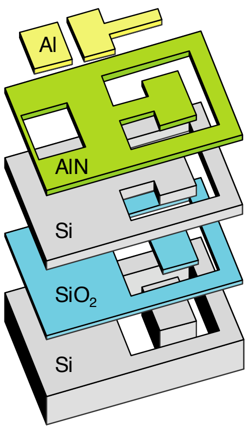


Ambient vibrations induce movement of the mass, and therefore deformation of the cantilever. The compression – elongation (first mode) of the piezoelectric layer creates electric charges that are collected by the electrodes (Silicon beam and Al layer) and transferred to the load. The latter must be tailored to maximise the power transfer.

Microfabrication process

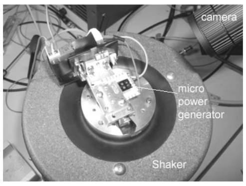
A specific MEMS process has been developed in cooperation with MEMSCAP-ESIEE in France.

The process begins with deposition of the AlN layer on a SOI substrate, which is then patterned to define contacts with the Silicon substrate. Then Aluminium layer is deposited and patterned to define the bonding pads, electrical connections and the top electrode. After that the moving structure is defined using Deep Reactive Ion Etching from both the bottom and the front side. Finally the silicon oxide layer is removed by selective etching and the structure is released.

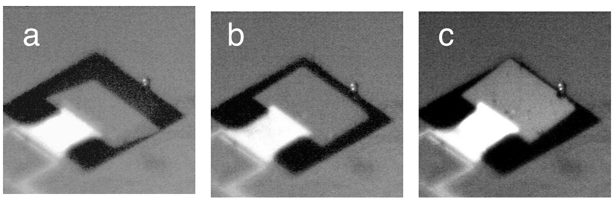


Vibration measurements

For characterizing the generator, the device has been placed on the head of a shaker. The device is placed near a calibrated accelerometer to monitor the incoming excitation vibration



The measurements made on the first prototype using an AlN layer have shown a power output of **38nW** for **0.5g** of excitation at the resonance freequency (**204Hz**)



Photos of the micro power generator excited at the resonance frequency, the pictures show low (a), neutral (b) and high position (c). The upper aluminium electrode appears in white. Images have been taken by a high speed APS camera working at 600fps

Contact: **Skandar.Basrour@imag.fr**
TIMA, 46 Avenue Felix Viallet, Grenoble, FRANCE
http://tima.imag.fr