



HAL
open science

Flexible Electro-Active Materials

Raynald Seveno, Thibault Dufay, Benoit Guiffard, Mohammed El Gibari,
Julien Le Scornec, Jean-Christophe Thomas, Pierre-Jean Cottinet, Mickael
Lallart, Lionel Petit, Vincent Le Cam

► **To cite this version:**

Raynald Seveno, Thibault Dufay, Benoit Guiffard, Mohammed El Gibari, Julien Le Scornec, et al.. Flexible Electro-Active Materials. World Electronics Forum, Oct 2017, Angers, France. 2017. hal-01714979

HAL Id: hal-01714979

<https://hal.science/hal-01714979v1>

Submitted on 22 Feb 2018

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Flexible Electro-Active Materials

R. Seveno¹, T. Dufay¹, B. Guiffard¹, M. El Gibari¹, J. Le Scornec¹, J.-C. Thomas², P.J. Cottinet³, M. Lallart³, L. Petit³, V. Le Cam⁴

¹IETR, ²GeM, University of Nantes (France)

³LGEF, INSA de Lyon (France)

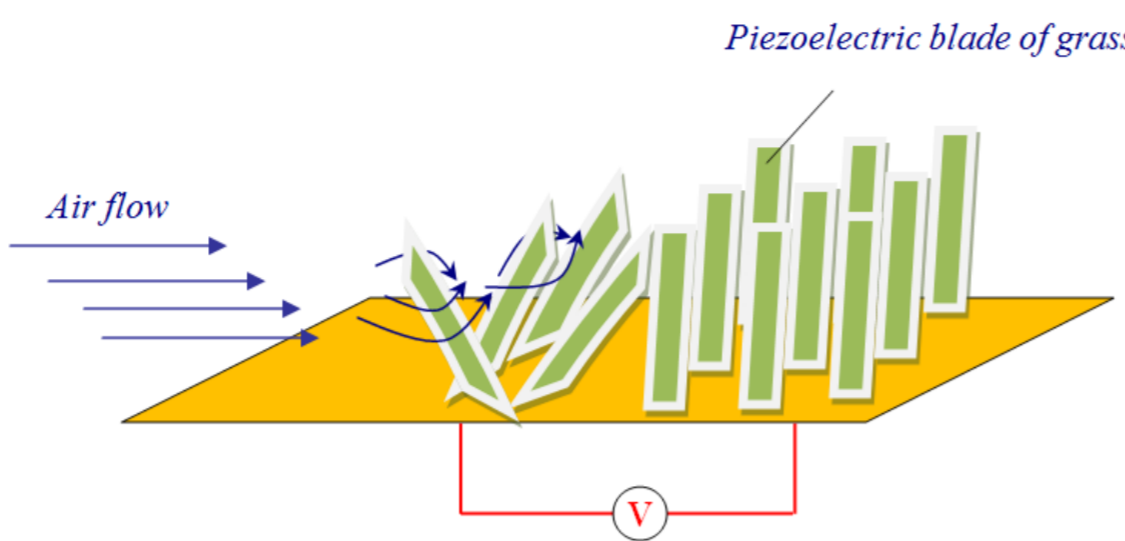
⁴IFSTTAR, Nantes (France)

Email : raynald.seveno@univ-nantes.fr



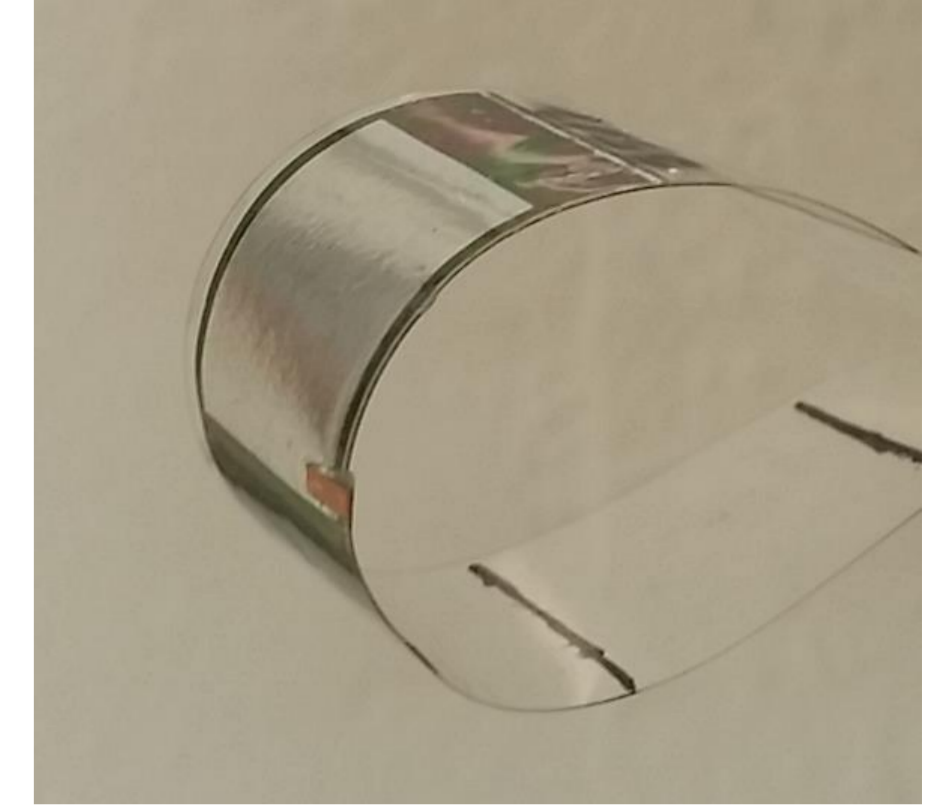
N-air-J and MIGAC projects

- Aim:** Synthetic blade of grass to convert wind energy into electricity
- Solution:** Use of flexible piezoelectric thin films
- Support:** Financial support provided by the french region Pays de la Loire and RFI WISE



Others applications

- Energy harvesting from other ambient energy sources (wave energy, body motion)
- Smart sensors (biomedical, buildings, health care, IOT, smart cities)
- Actuators showing high displacements (centimeter range)



Flexible piezoelectric thin films

Lead zirconate titanate (PZT) films



PZT on Aluminium



PZT on PET

Fabrication process easily transferable to industry

low cost: 280 €/m²

0.5 cm × 4 cm beam = 5.6 cents

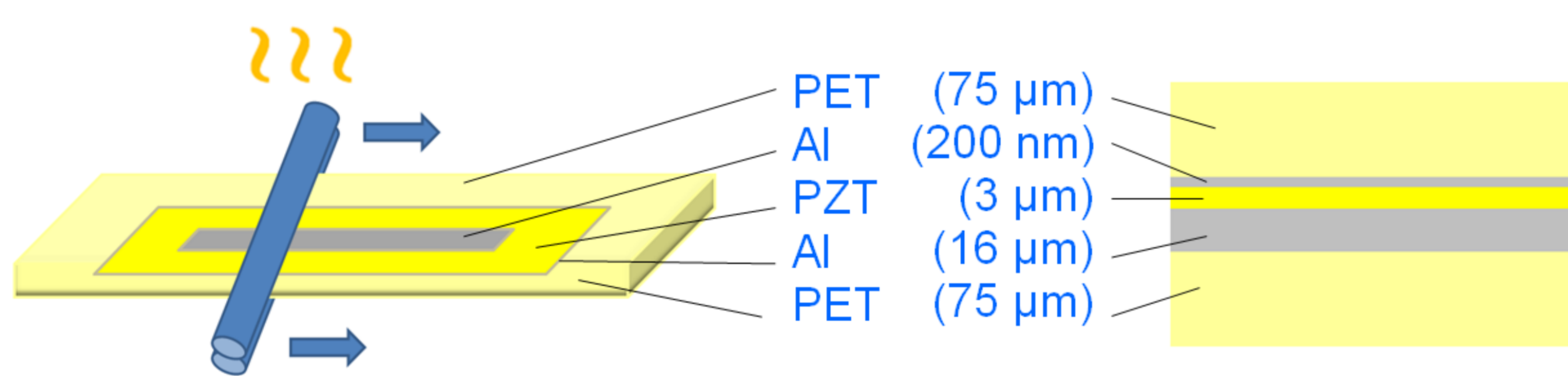


Cut able



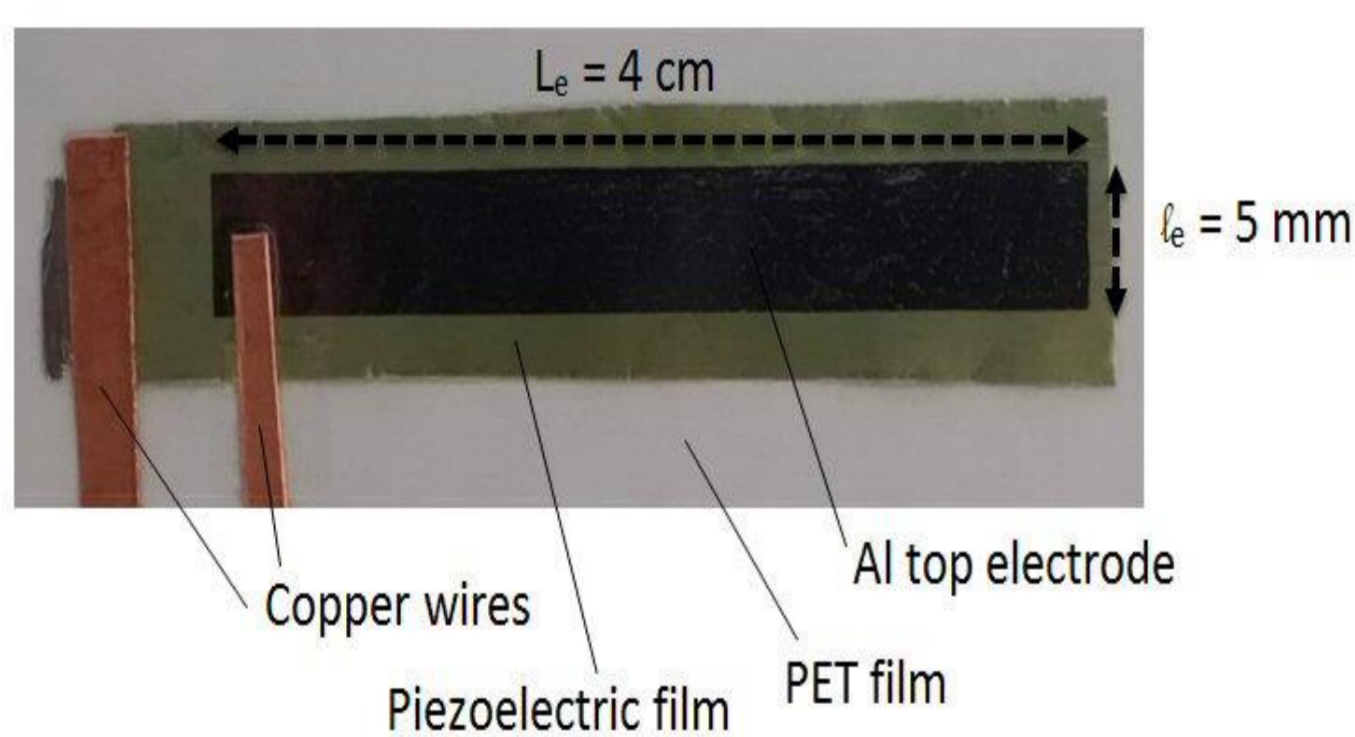
3D shape

Non conventional shapes



Preparation of the composite by lamination of the PET

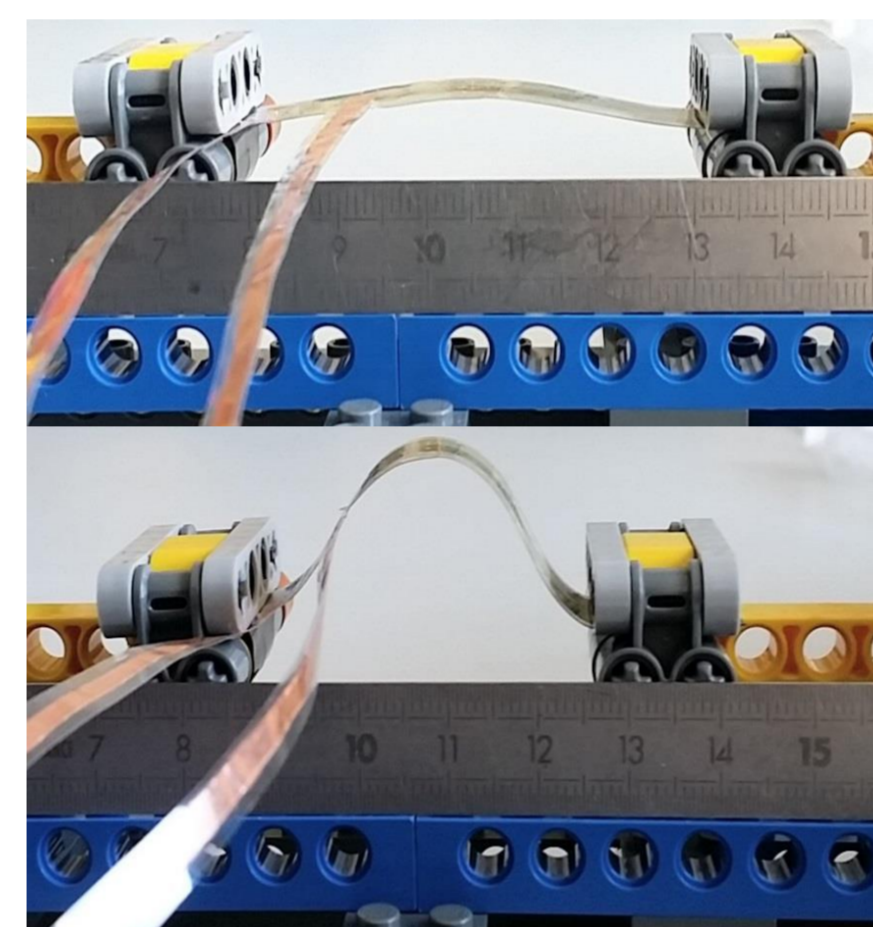
Sectional view of the composite



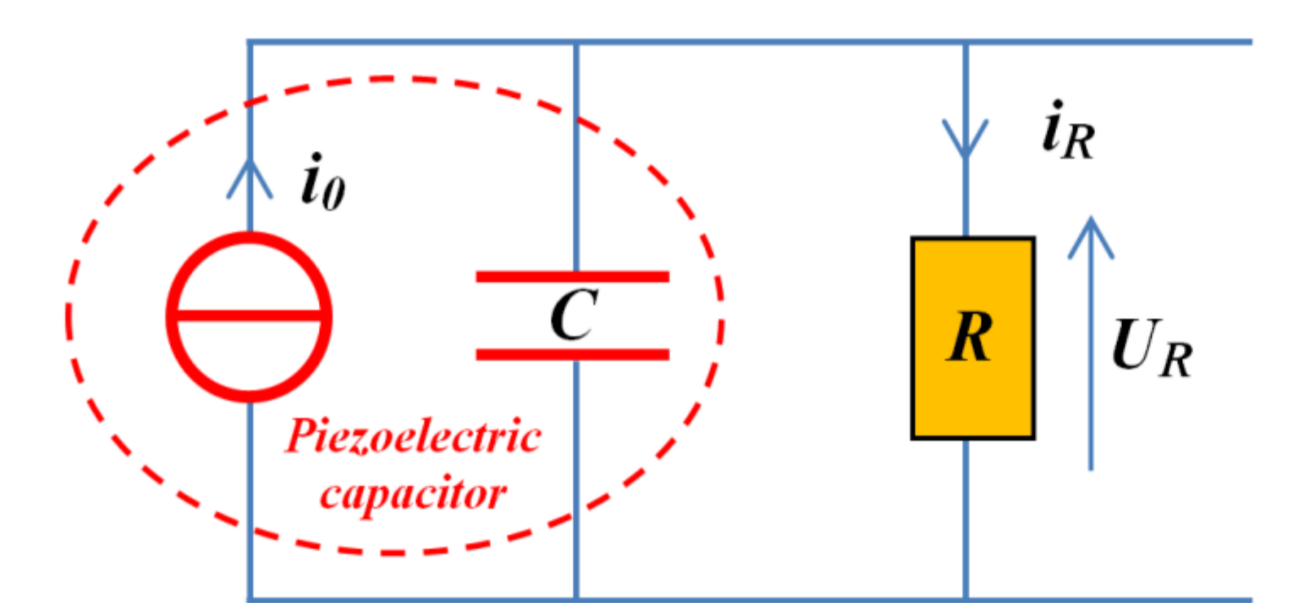
Flexible and watertight

Energy harvesting

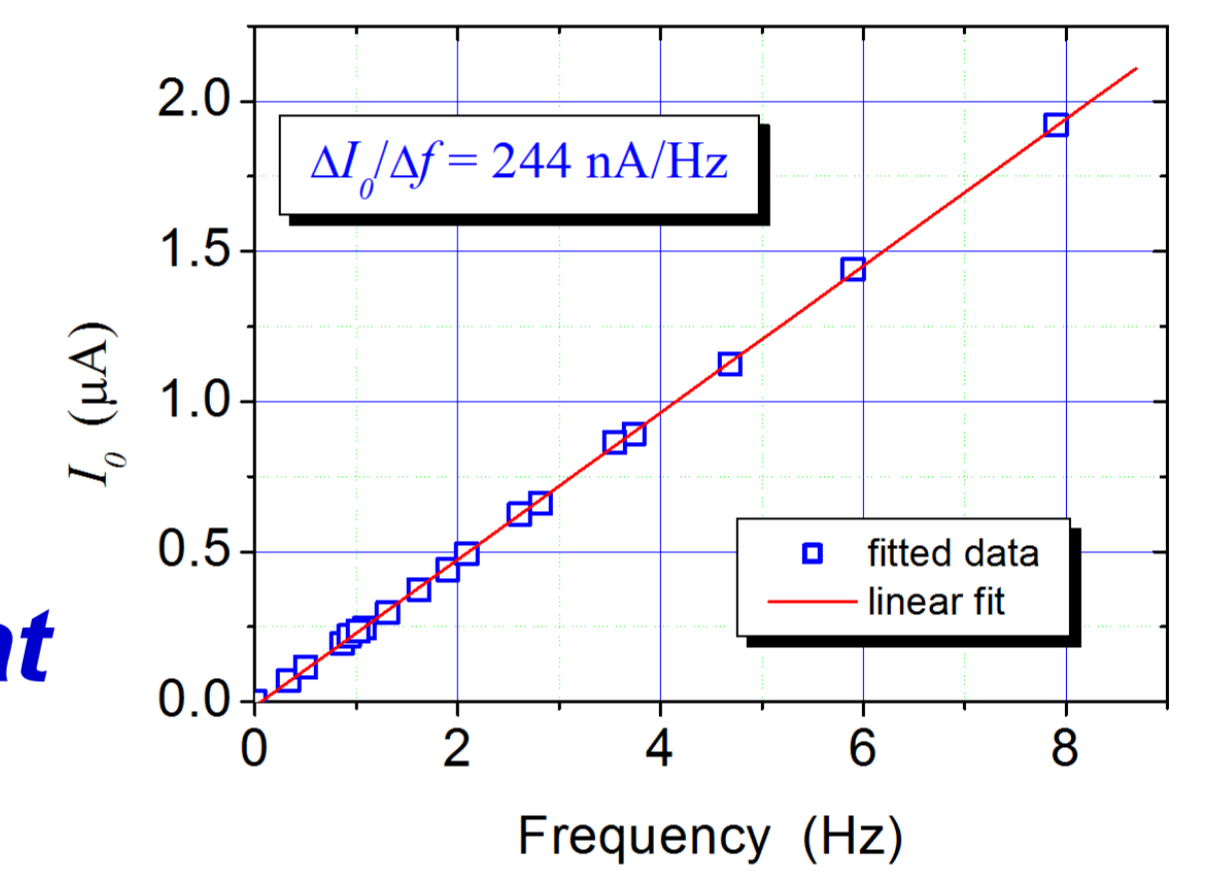
Mechanical excitation of the piezoelectric blade



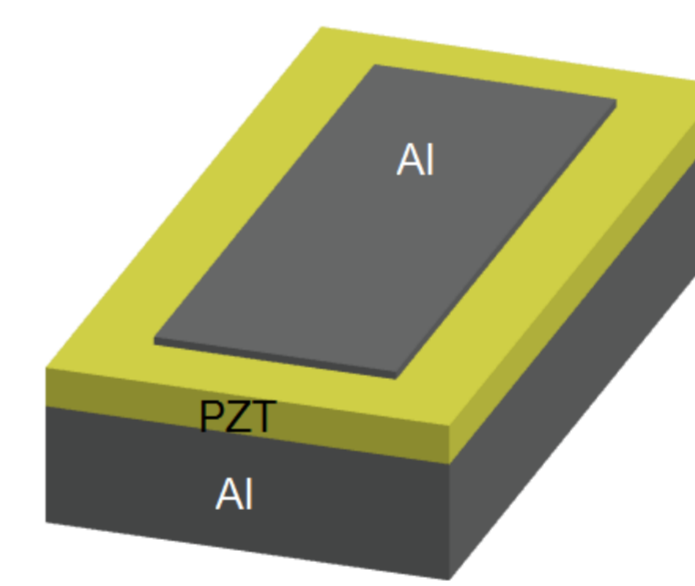
Scheme of the equivalent circuit of the energy harvesting device :



Piezoelectric current

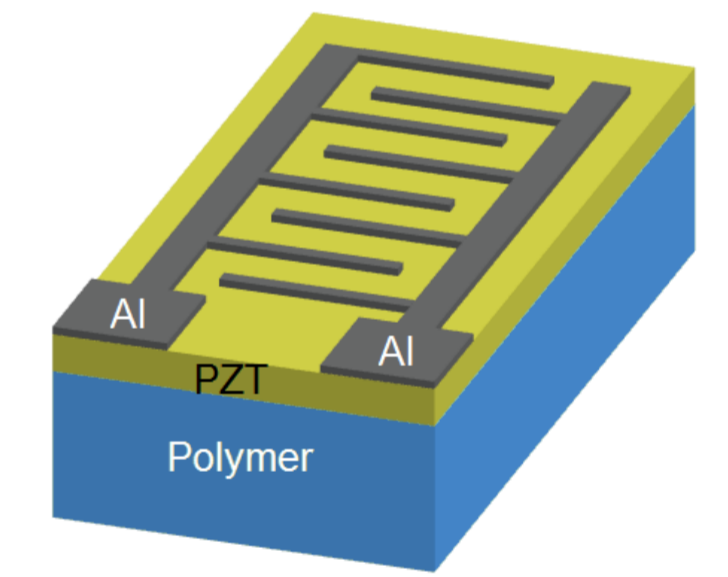


Harvesting device working at very low frequencies

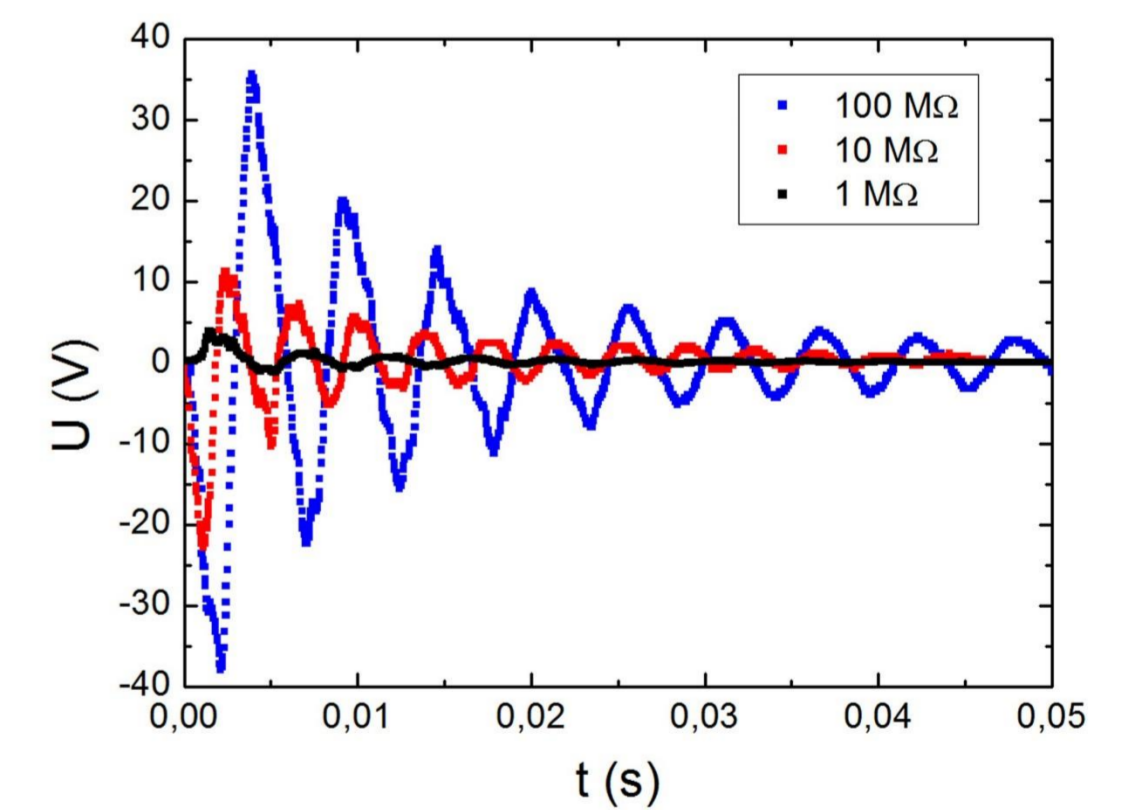
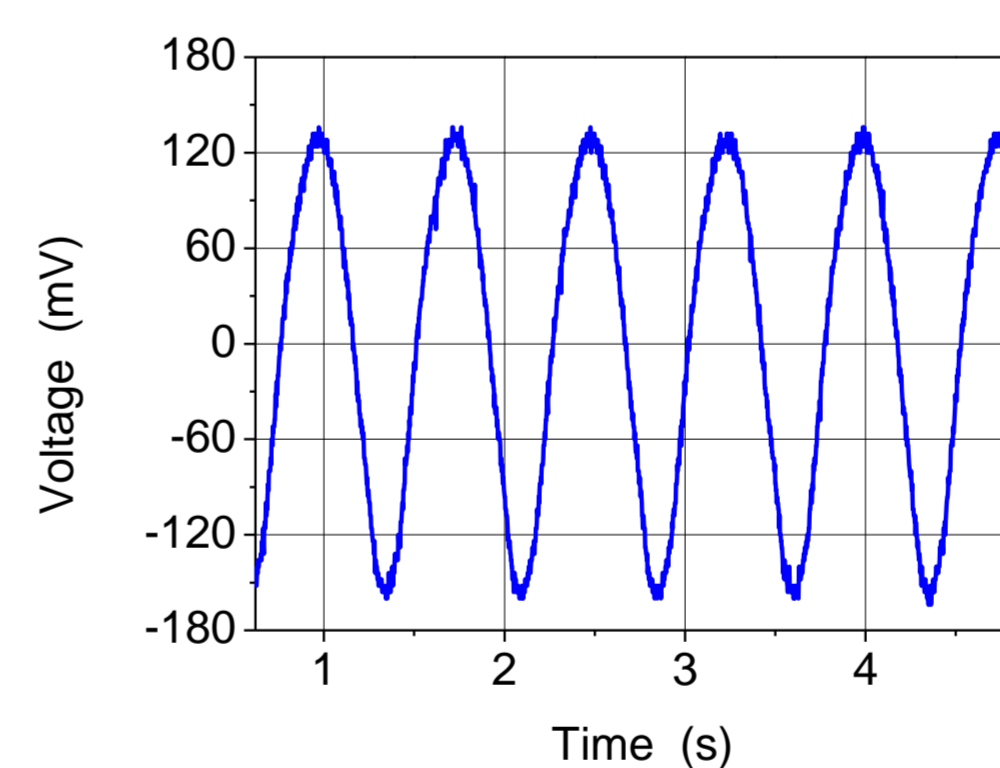


MIM structure

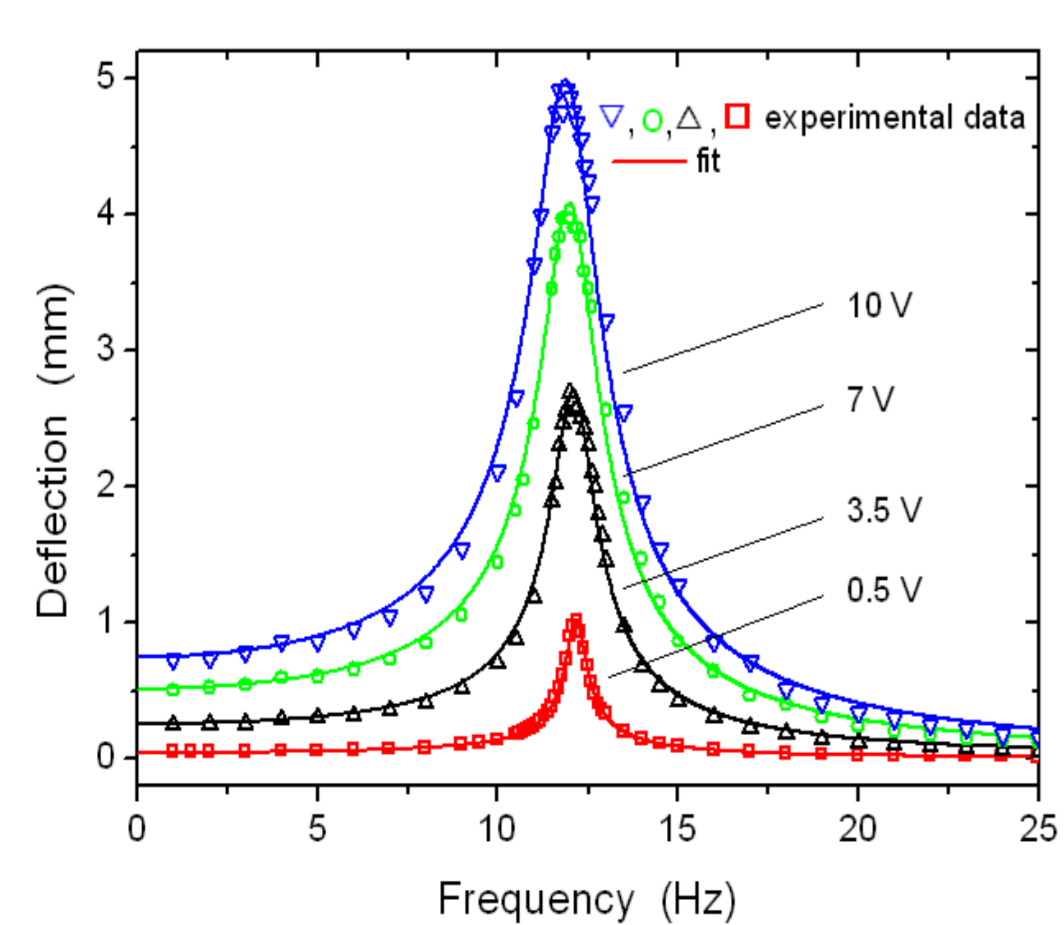
Output voltage X 100



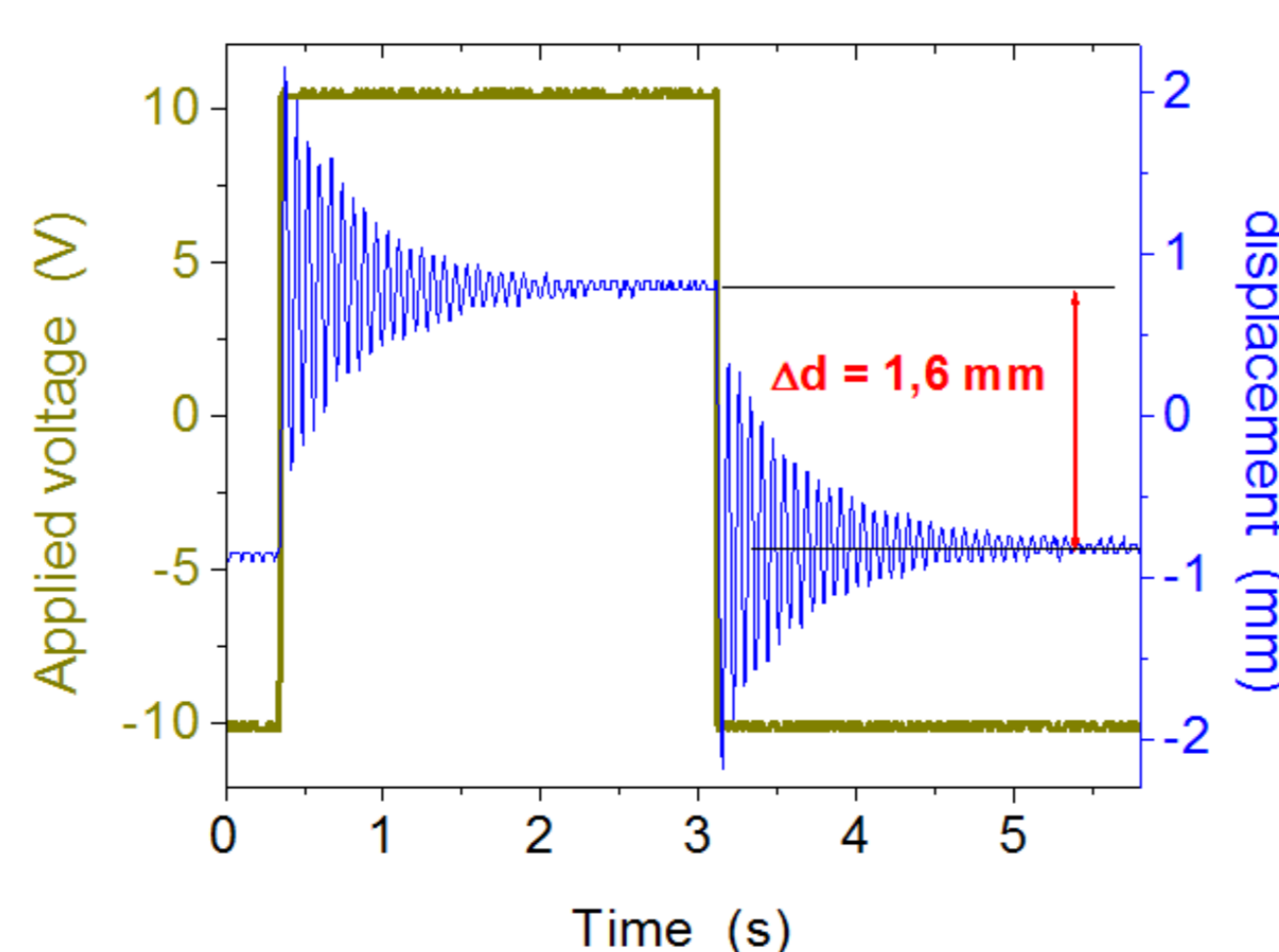
IDE structure



High bending mode actuation properties



Sinusoidal electrical excitations



ON/OFF " mode

milimetric deflections at low applied voltages

Flexoelectric polymers for large curvature sensing

Flexoelectricity: Mechanical-to-electrical coupling between strain gradient (curvature) and electrical polarization P_{flex} in every solid dielectrics → Flexoelectric effect in soft polymer films may be used for the development of low cost and easy to implement elastomer-based large curvature sensors on highly flexible metallic structures

Strain gradient

Curvature

$$P_{flex} = \mu \left(\frac{\partial S}{\partial x} \right) = \mu C$$

Flexoelectric coefficient μ



Polyurethane (PU) film

PU thin films ($e=6 \mu m$) deposited onto Al foil /PET flexible cantilever → direct sensing of large curvature ($80 m^{-1}$) = radius of curvature ($\sim 1 cm$)

