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Flexible Electro-Active Materials

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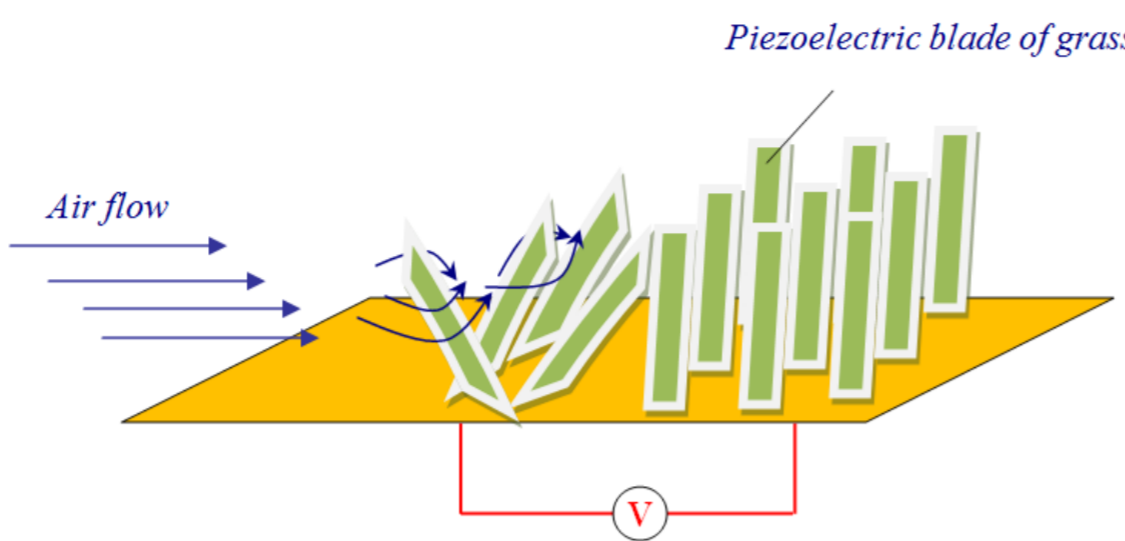
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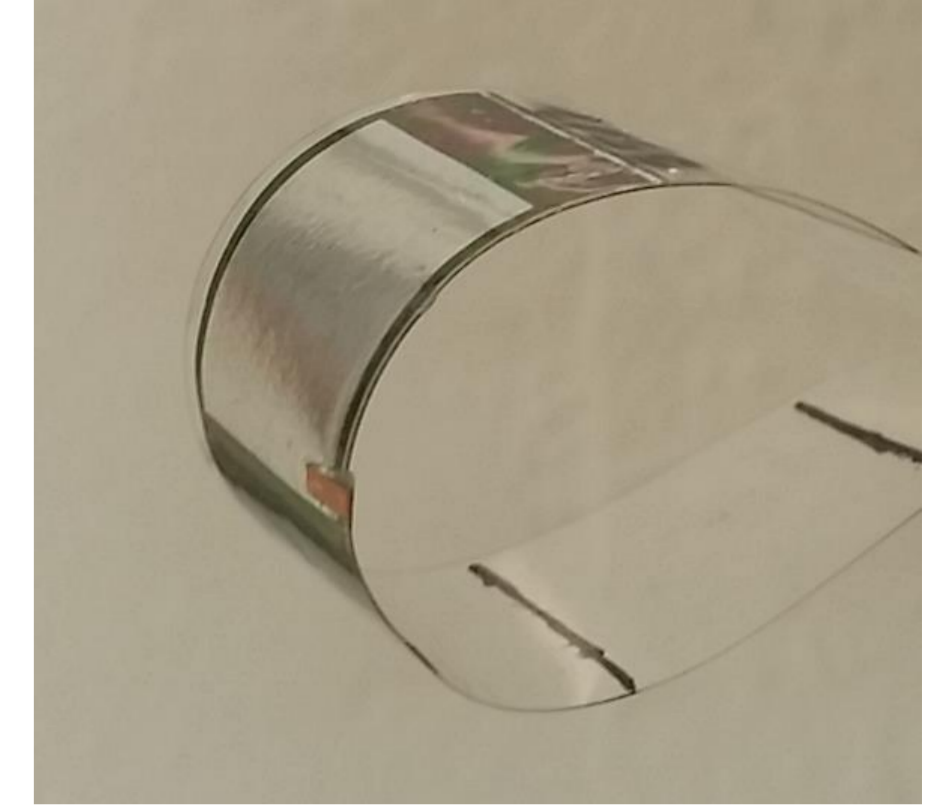
N-air-J and MIGAC projects

- 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

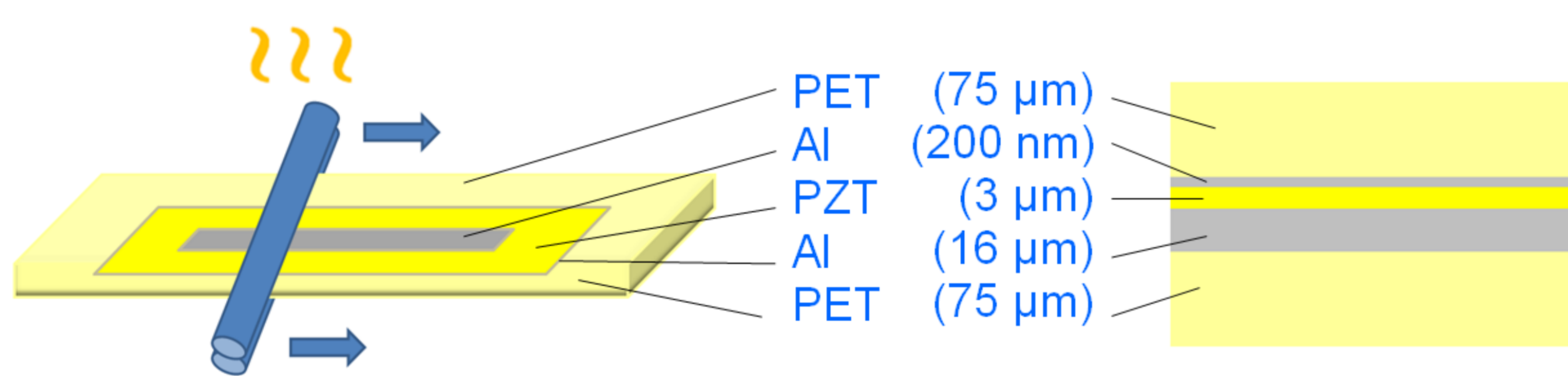


Cut able



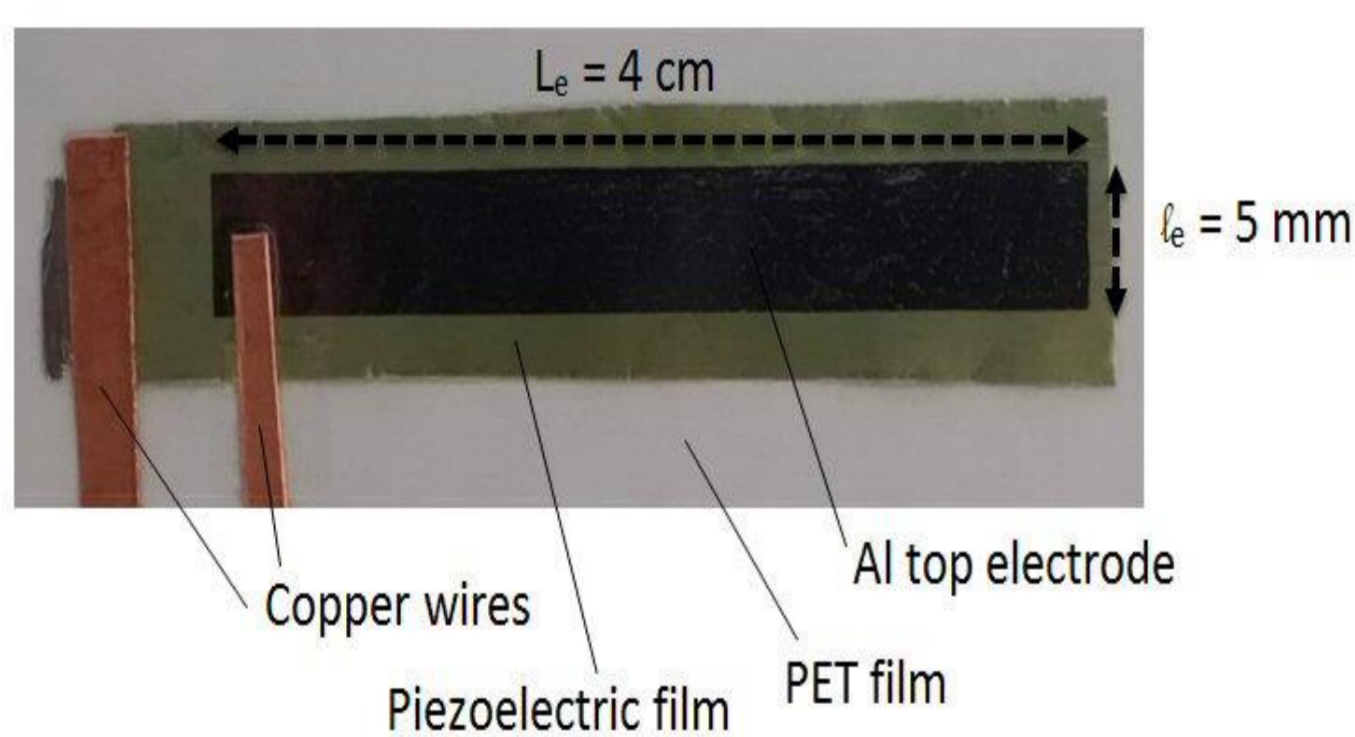
3D shape

Non conventional shapes



Preparation of the composite by lamination of the PET

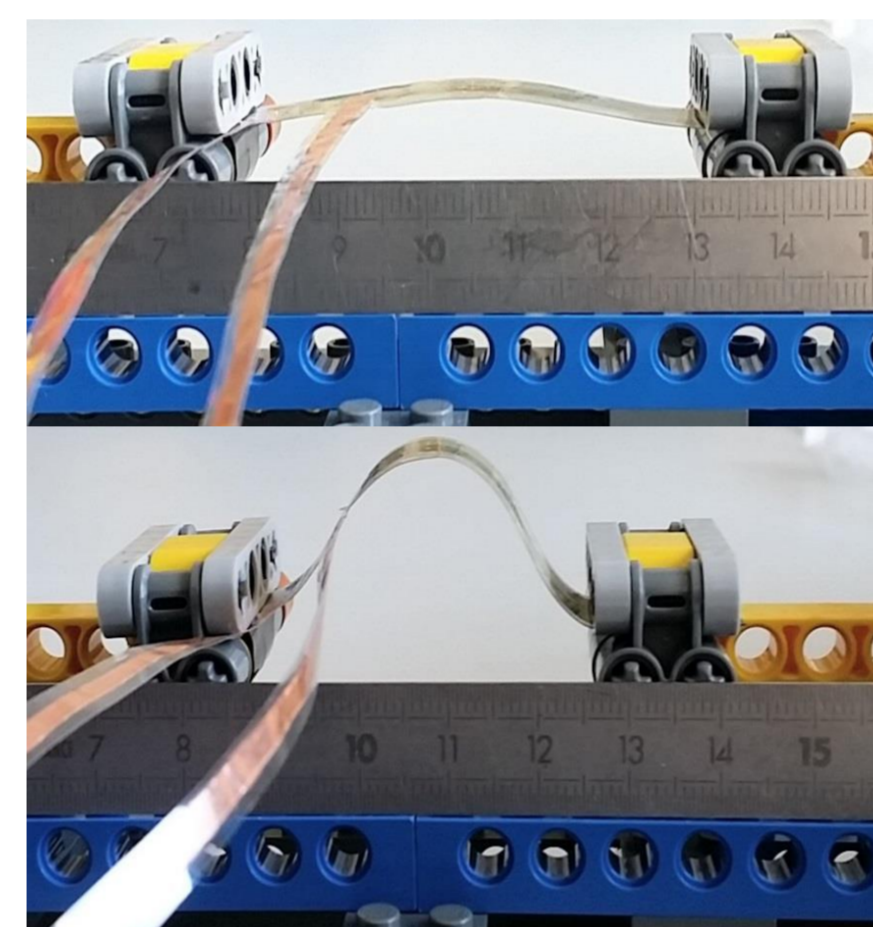
Sectional view of the composite



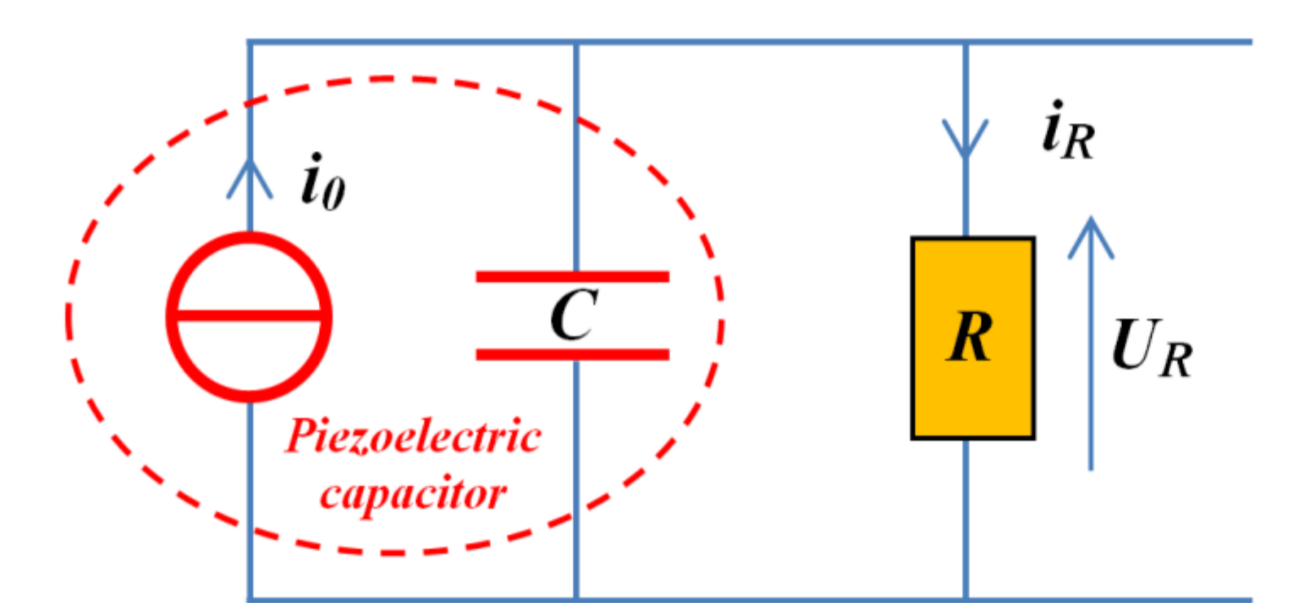
Flexible and watertight

Energy harvesting

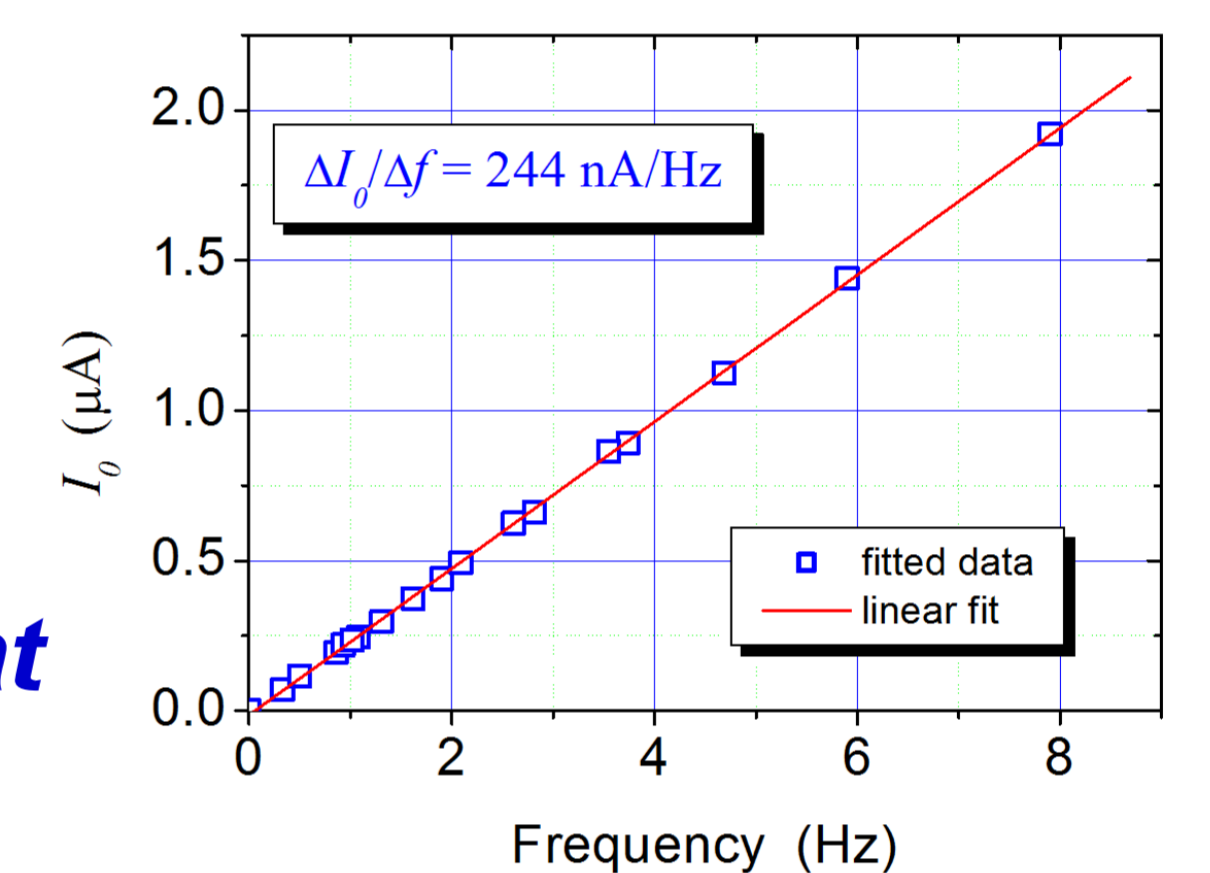
Mechanical excitation of the piezoelectric blade



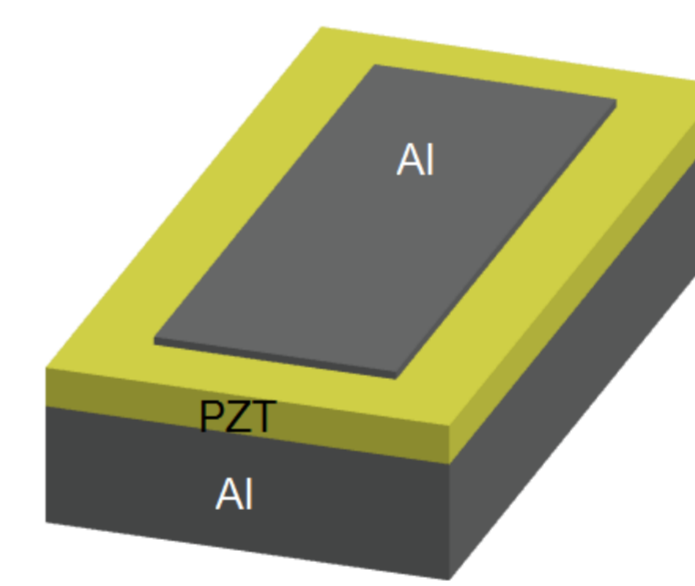
Scheme of the equivalent circuit of the energy harvesting device :



Piezoelectric current

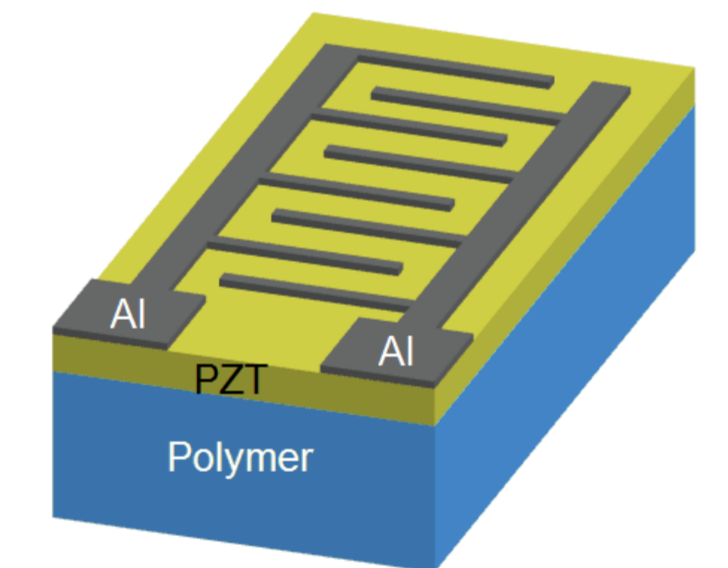


Harvesting device working at very low frequencies

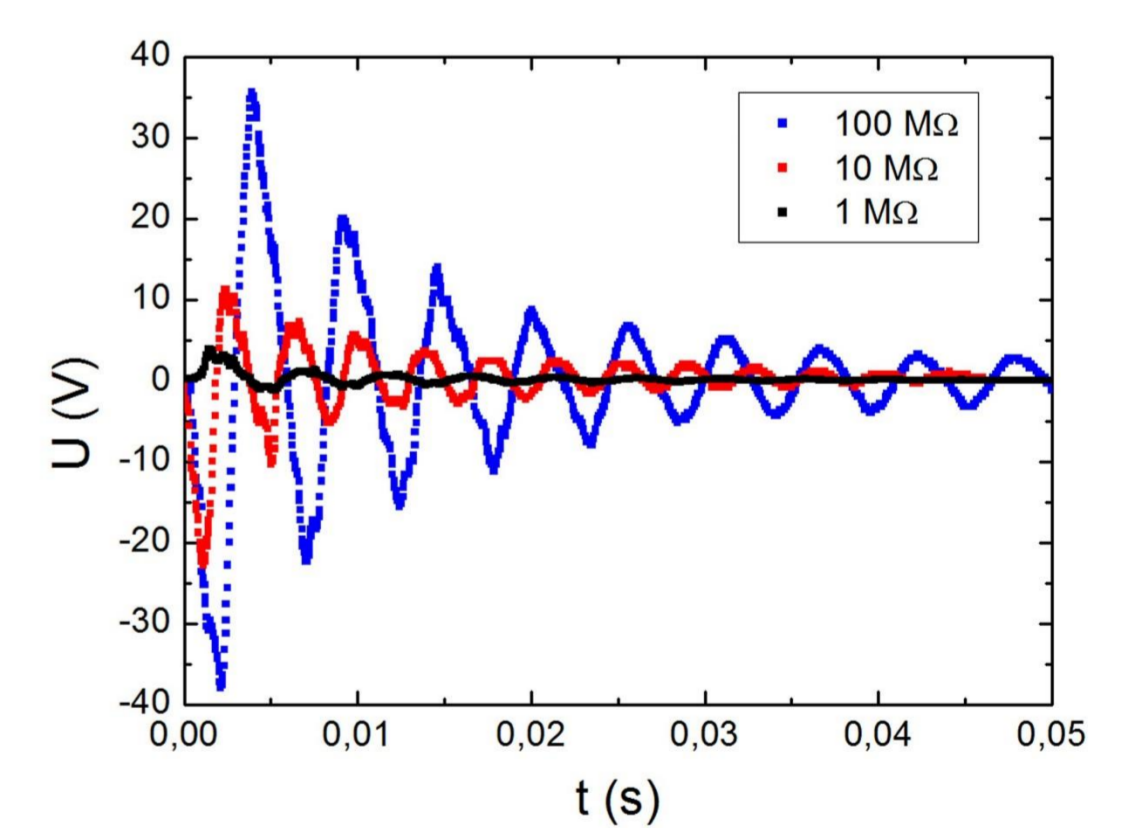
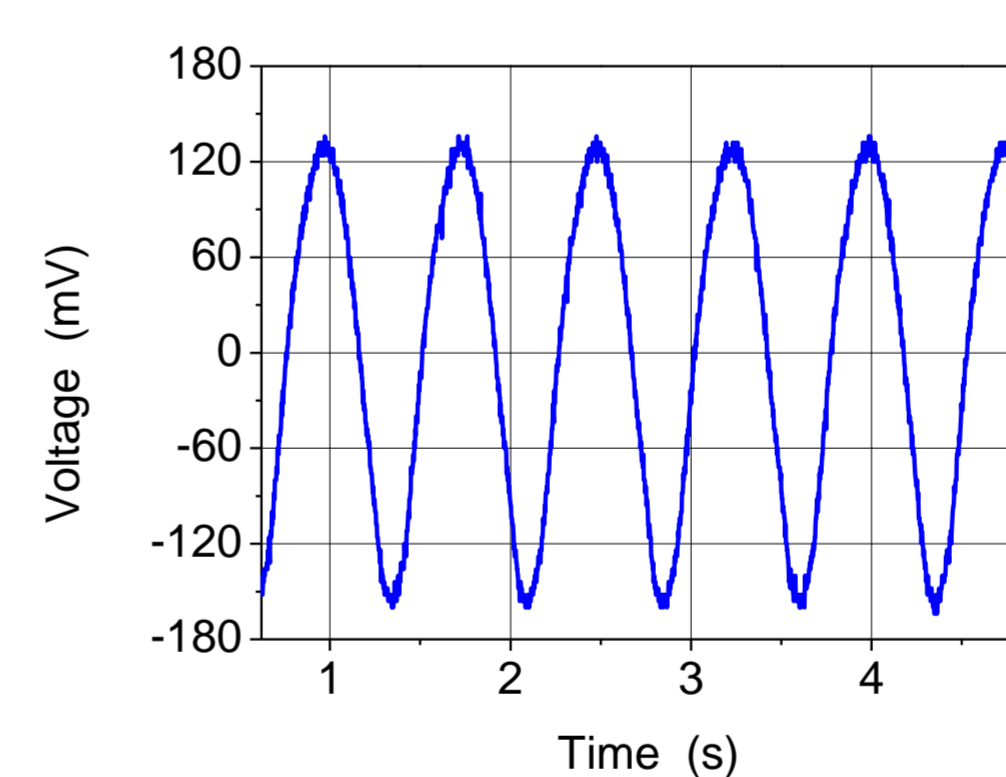


MIM structure

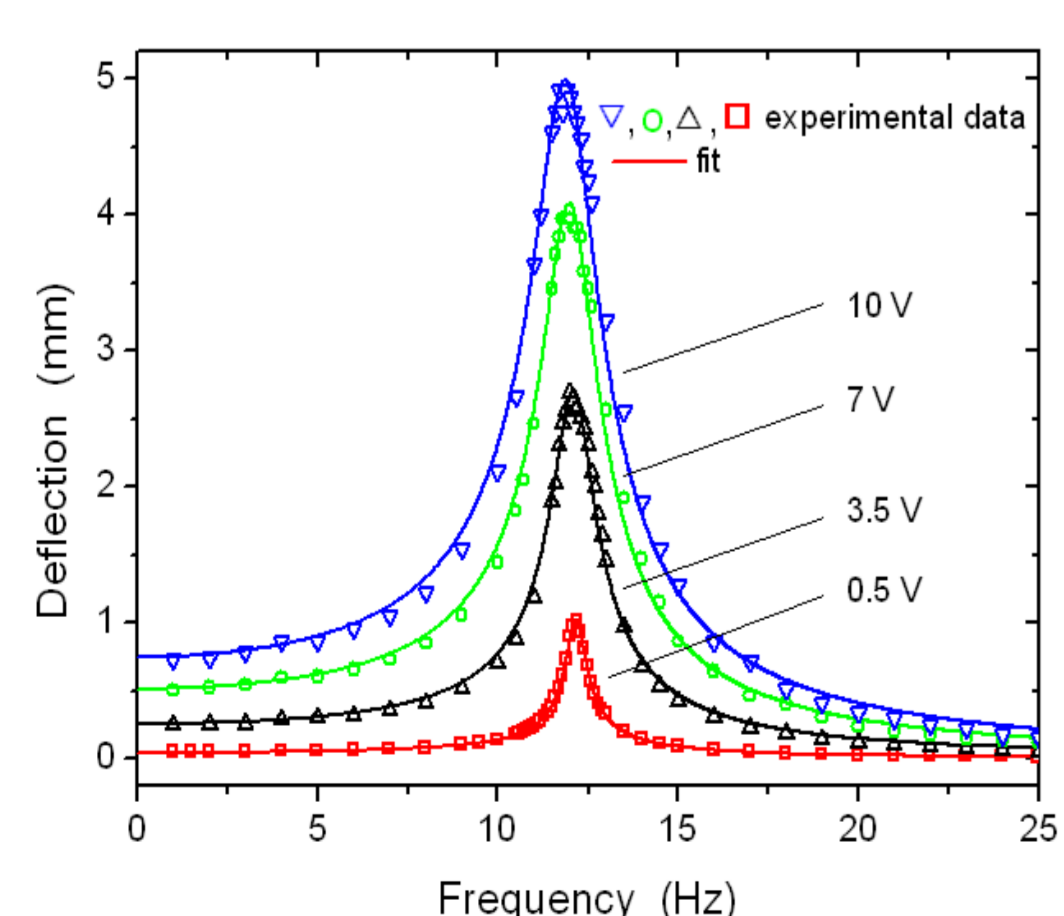
Output voltage X 100



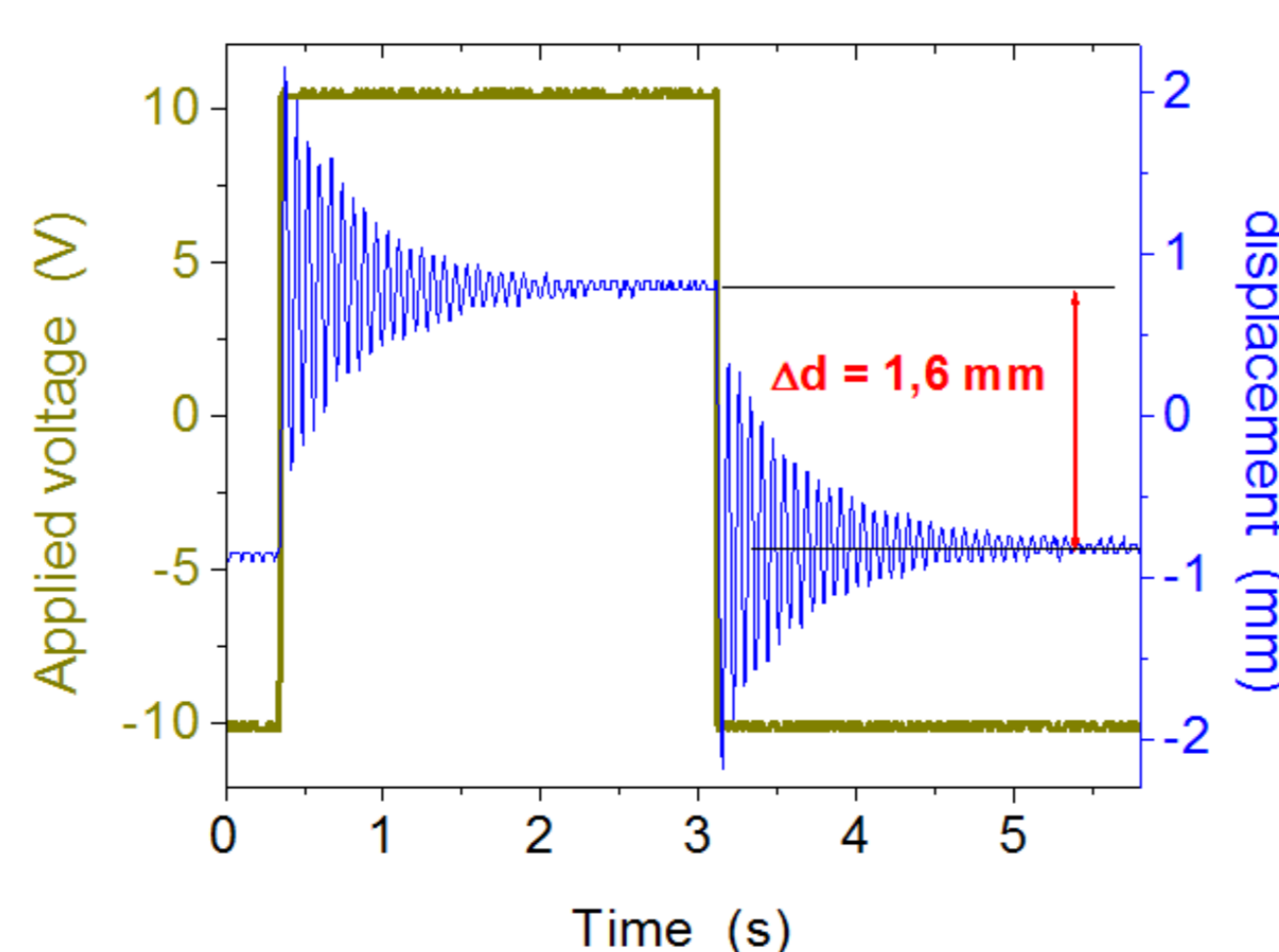
IDE structure



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 ($e = 6$ μm) deposited onto Al foil /PET flexible cantilever → direct sensing of large curvature (80 m⁻¹) = radius of curvature (~ 1 cm)

