



### Energy Harvesting from Pyro-electricity and Piezoelectricity

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#### BACKGROUND and BASICS

Harvesting energy from the environment: wind and heat

- Aim: powering electronic systems beyond batteries
- Electronic systems submerged in air flows

Special materials generate electrical power when:

- Stressed - Piezoelectric (mechanical vibrations)
  - Heated - Pyroelectric (thermal fluctuations)
  - Submitted to electrical field – ferroelectric
- These materials are well known as sensors and are being extended towards harvesters.

Competences of the ISI group

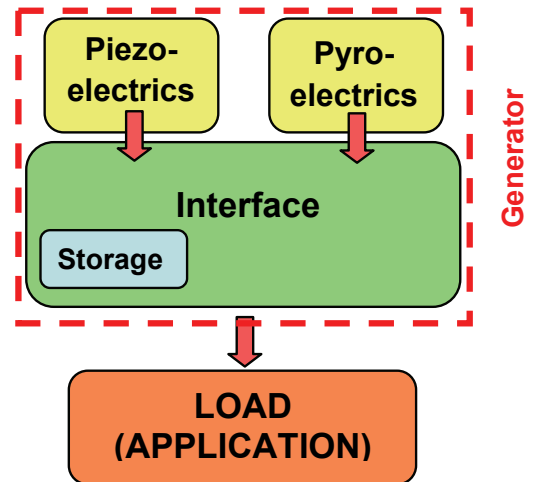
- Autonomous sensors platforms: from energy harvesting to sensor node communications.



PVDF film hanging on the support to harvest the energy from the wind and temperature fluctuations of the environment. PVDF is a pyro and piezoelectric polymer.

#### CONCEPT and SOLUTION

- Wind is widely used in electrical generation at large scales.
- Temperature fluctuations from 10 to 70 °C are converted.
- Conveniently designed thin films mounted on a bluff body simultaneously harvest thermal and mechanical energy from the environment.
- High voltage levels achieved: Simple rectification
- Simplicity, mass production elements.
- Mechanical waves induce parallel piezoelectric generators in the film.
- Generators of 5 to 40 cm<sup>2</sup>. Miniaturization could be possible.
- Working in normal wind conditions (5 - 15 km/h)



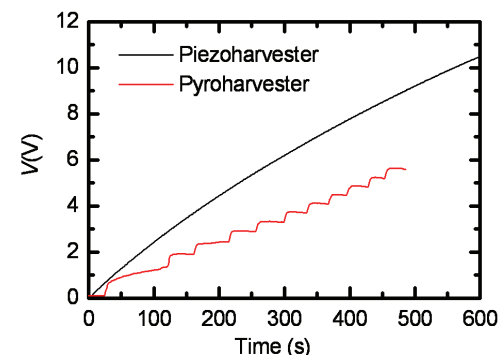
Energy harvesting generator to power a low power load.

#### STATUS and OUTLOOK

- Characterization of energy generation and efficiencies.
- Mathematical modeling of the structures.
- Improving film design. Material selection.
- Effective interface to maximize the harvested energy with the combination of piezo and pyro conversions.

Looking for:

- Companies interested in energy harvesting.
- Material production centers for energy harvesting applications.



Voltage stored in a capacitor for wind generation and thermal fluctuations.

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MICROTECHNOLOGY 2009