



University of Constantine
Science and Technology Faculty
Electronic Departement
Laboratory of Hyperfrequencies and Semi-conductor
(LHS)



Simulation of Piezoelectric Nanofibers For Harvesting Energy Applications

Rouabah Sawsen and Chaabi Abdelhafid

OVERVIEW

1

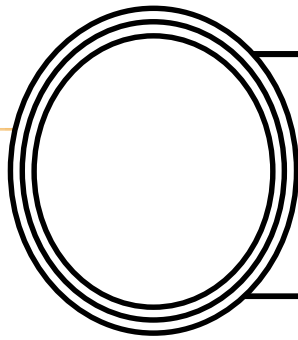
Introduction

2

Comsol Simulation

3

Conclusion



Introduction



Introduction



Piezoelectric Nanofibers

Introduction

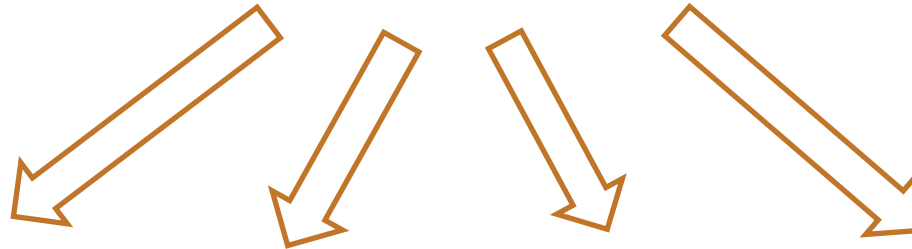
Ferroelectric materials



Piezoelectric
Materials

piezoelectric

ferroelectric



Transducers



Sensors



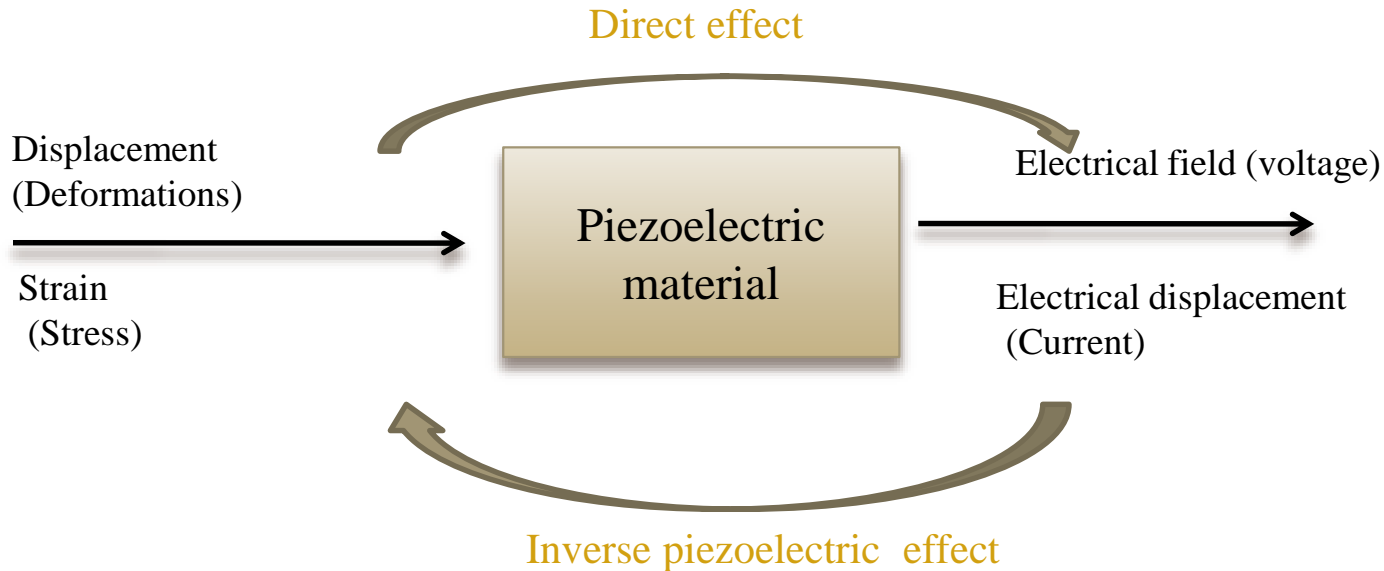
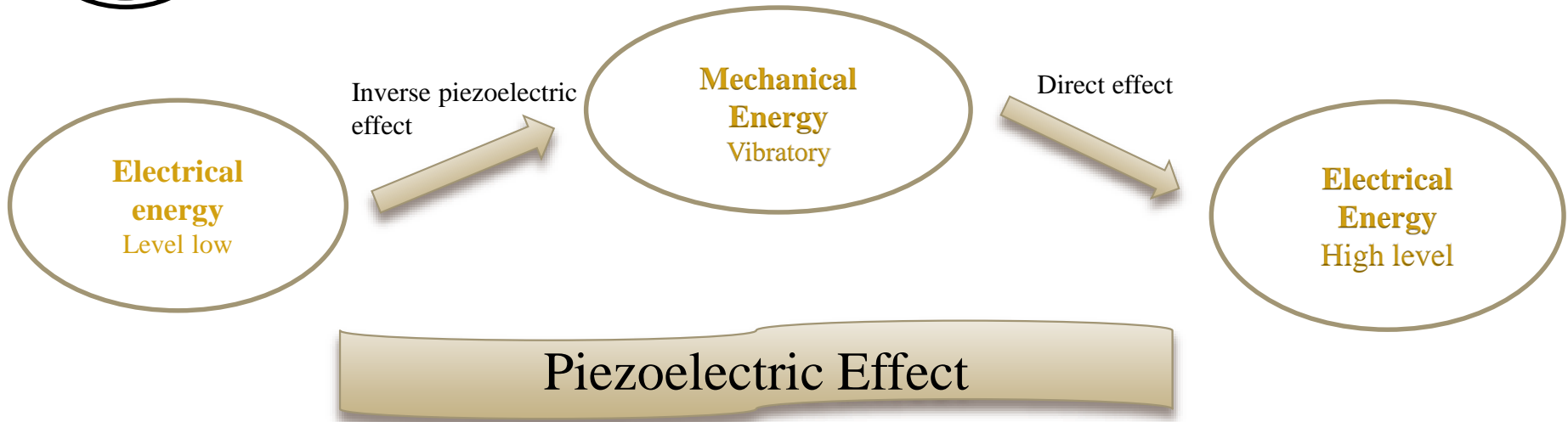
Actuators

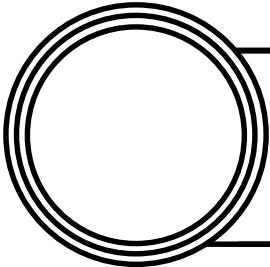


Energy Harvesting

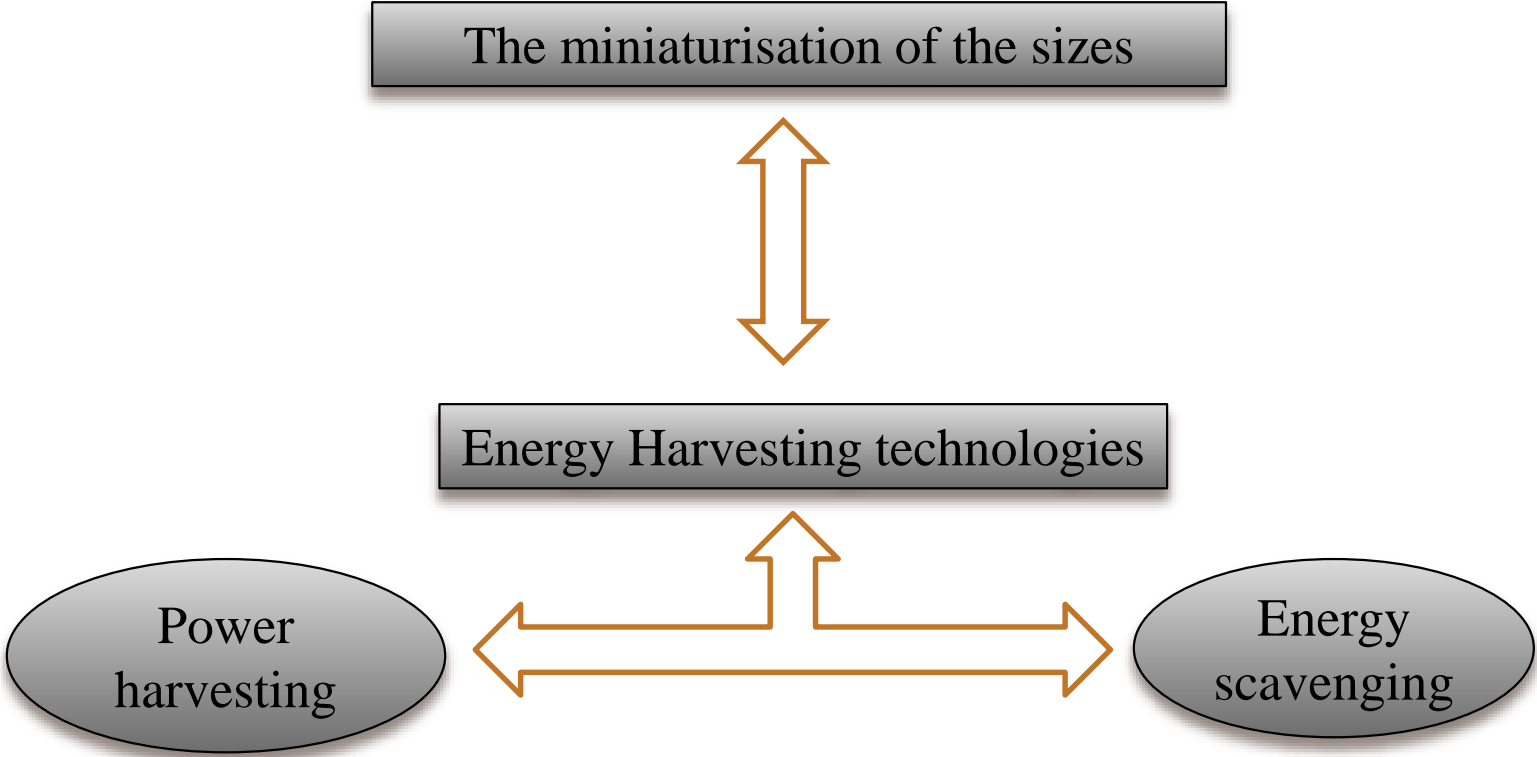


Introduction

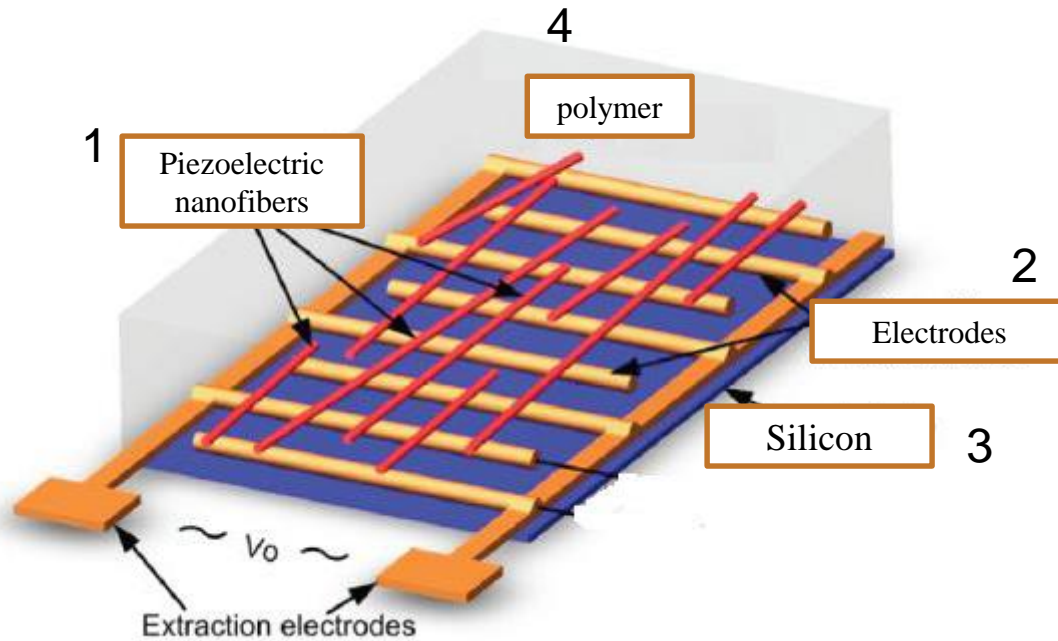




Introduction



Piezoelectric Nanofibers



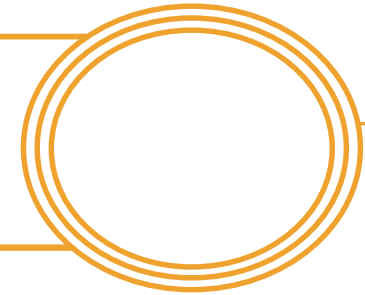
1 The nanofibers are constructed by electrospinning process using piezoelectric materials

2 After constructing , they deposited on the prepared interdigitated electrodes

3 They deposited on a silicon substrate

4 PEHD was applied on the top

Comsol Simulation



- **Structure and Design**
- **Selected Materials**
- **Mesh**
- **Results**

Structure and Design

START

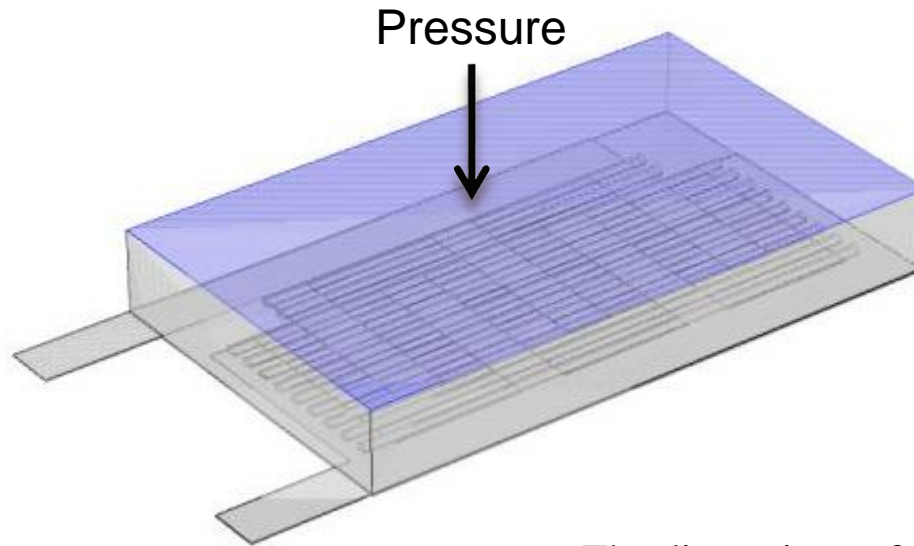


- Thermoelasticity (te)
- Joule Heating and Therr
- Piezoelectric Devices
- Piezoresistivity
- Electromechanics (emi)

- AC/DC
 - Electric Currents (ec)
 - Electric Currents, Shell (ecs)
 - Electrical Circuit (cir)



- Preset Studies for Selected Physics Interfaces
 - Frequency Domain
 - Frequency-Domain Modal



The dimensions of each part:

Silicon Substrate	Lenght =0.005mm Width=0.003mm Thickness= 10-5mm
Nanofibers	Radius=50nm Lenght=4.5μm
Polymer rectangular	Lenght= 5μm Width=3μm Thickness= 0.7μm

Selected Materials

Selected Materials:

For the nanofibers: PZT 5H (Lead Zirconate Titanate).

The polymer used: PEHD (Polyethylene).

For the electrodes: The copper

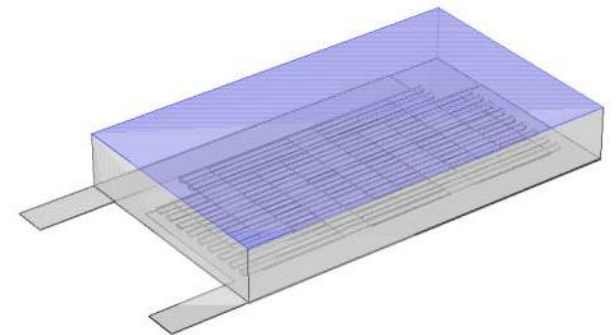
Polarization:

We apply a pressure on the surface of the polymer to 50N/m^2

Boundary load

Definition

Piezoelectric devices

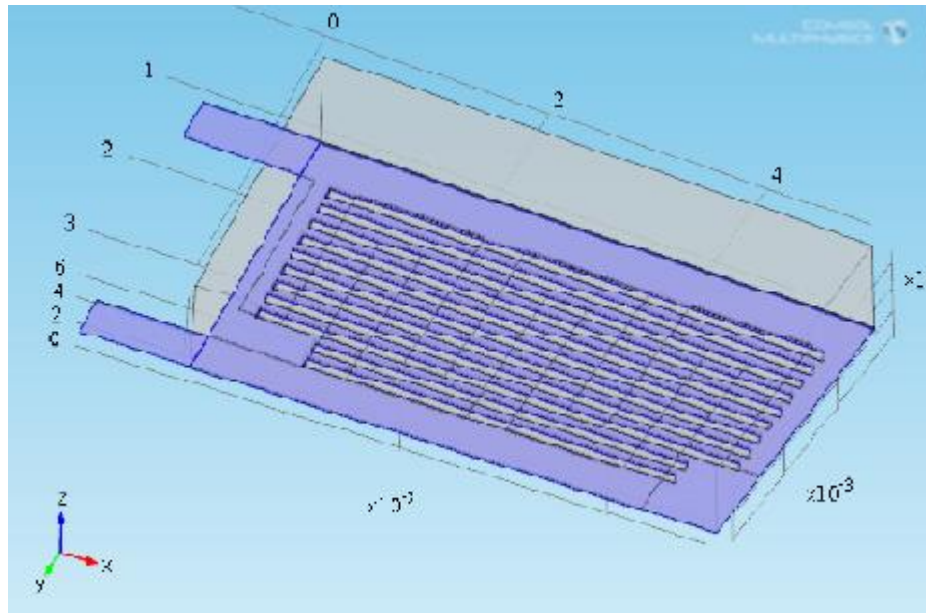
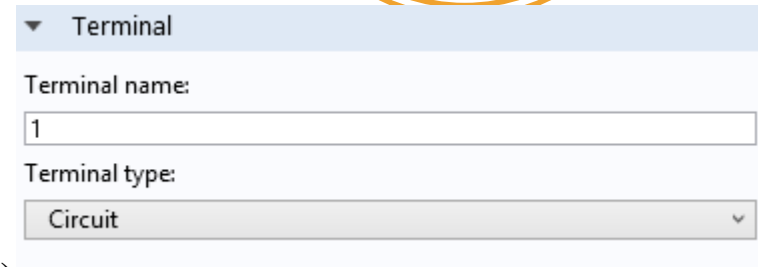


Mesh

Electrode boundary conditions:

The high of Electrodes → Terminal

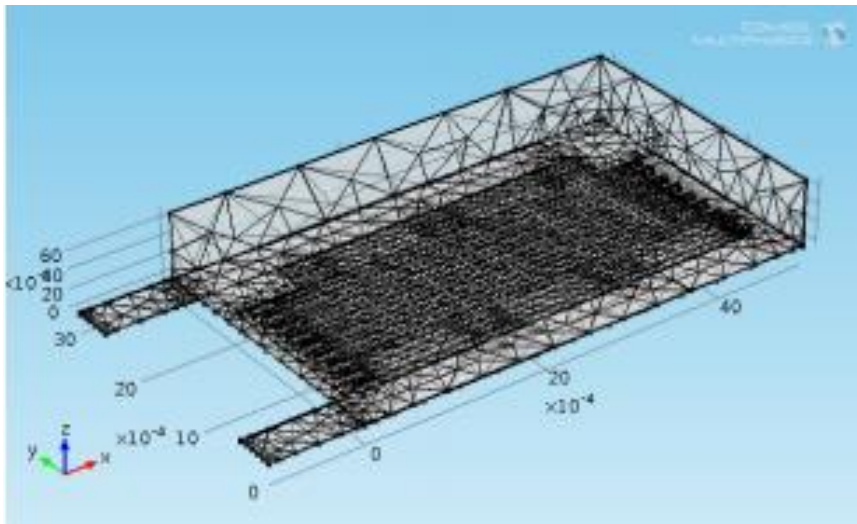
The other face of electrodes → Ground (GND)



Mesh



Mesh:

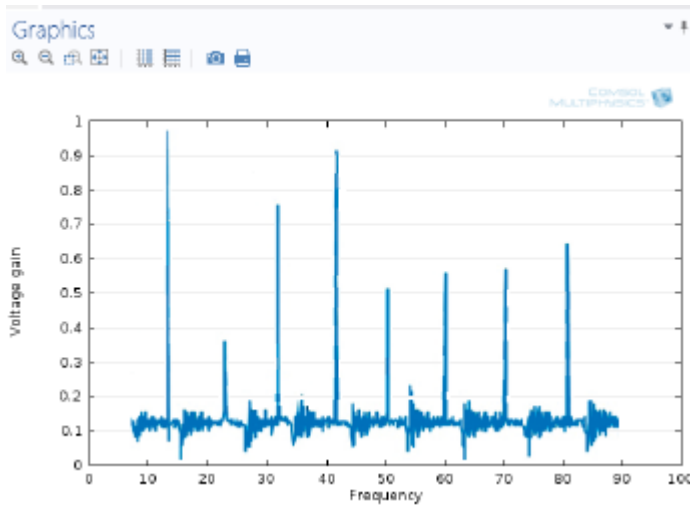


**Physics controlled
mesh**

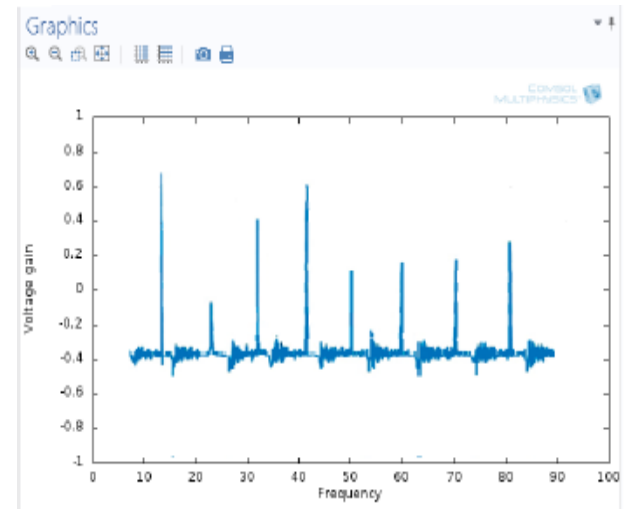
**Element size extra
coarse**

Results

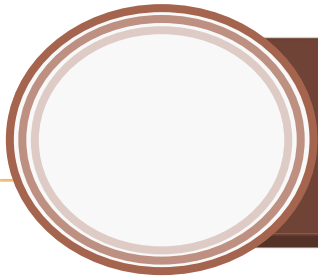
At 50N/m²



At 10N/m²



Output voltage depending on frequencies



Conclusion

- ✦ The piezoelectric nanofibers are simulated using Comsol Multiphysics software, which is very useful for this study
- ✦ Piezoelectric nanogenerator based on lead zirconate titanate nanofibers, shows that piezoelectric voltage is high and powerful for energy harvesting.



Next work.....

- ➔ Optimization our piezoelectric nanofibers
- ➔ Change our polymer to a flexible one.....?

Thank you for your attention

