Simulation of Piezoelectric Nanofibers For Harvesting Energy Applications

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1. Introduction
2. Comsol Simulation
3. Conclusion
Introduction

Ferroelectric materials

Piezoelectric Materials

Transducers
Sensors
Actuators
Energy Harvesting
Introduction

Mechanical Energy
Vibratory

Electrical Energy
High level

Electrical energy
Level low

Inverse piezoelectric effect

Piezoelectric Effect

Direct effect

Displacement (Deformations)
Strain (Stress)

Piezoelectric material

Electrical field (voltage)
Electrical displacement (Current)

Inverse piezoelectric effect
Introduction

The miniaturisation of the sizes

Energy Harvesting technologies

Power harvesting

Energy scavenging

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1. The nanofibers are constructed by electrospining 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

The dimensions of each part:

<table>
<thead>
<tr>
<th>Material</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon Substrate</td>
<td>Lenght =0.005mm, Width=0.003mm, Thickness= 10-5mm</td>
</tr>
<tr>
<td>Nanofibers</td>
<td>Radius=50nm, Lenght=4.5μm</td>
</tr>
<tr>
<td>Polymer rectangular</td>
<td>Lenght= 5μm, Width=3μm, Thickness= 0.7μm</td>
</tr>
</tbody>
</table>
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
**Electrode boundary conditions:**
The high of Electrodes $\rightarrow$ Terminal

The other face of electrodes $\rightarrow$ Ground (GND)
Mesh:

Physics controlled mesh

Element size extra coarse
Results

At 50N/m^2

Output voltage depending on frequencies

At 10N/m^2

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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