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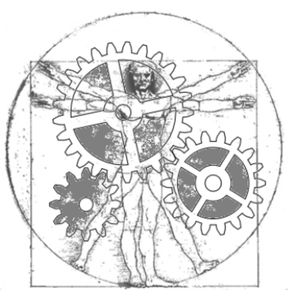
BodyPoweredSenSE RTD 2013

FNSNF

Flexible On-Body Piezoelectric Energy Harvesting



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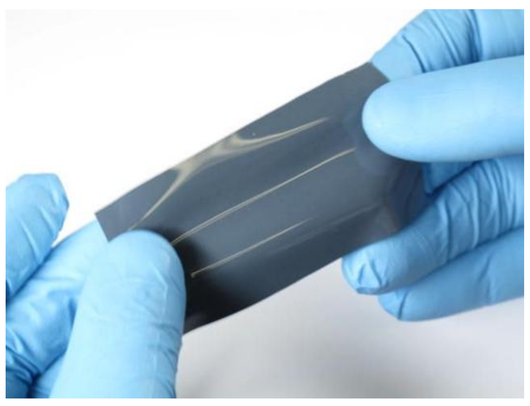
INTRODUCTION

Medical research as of late has placed an increasing interest on long term physiological monitoring of patients while engaging in day to day activities. Barriers to such long-term monitoring include the use of bulky electronics and single use batteries. Both the large form factor and the need to constantly monitor and replace batteries, ultimately make the use of and operation of current wearable sensors difficult and unfriendly for patients whom are young, elderly, or are otherwise incapacitated. Long term sensing scenarios in this project include the early detection of both Alzheimer's disease and epilepsy in young children. Being responsible for piezoelectric energy harvesting, our group is utilizing PDMS and plastic foil composite materials that can be readily scaled up for large area production. By exploiting large area fabrication techniques will ultimately lead to the development of highly compliant flexible garments capable of harvesting energy from breathing and body movements.

Piezoelectric Nanocomposite Generators

Why Nanocomposites?

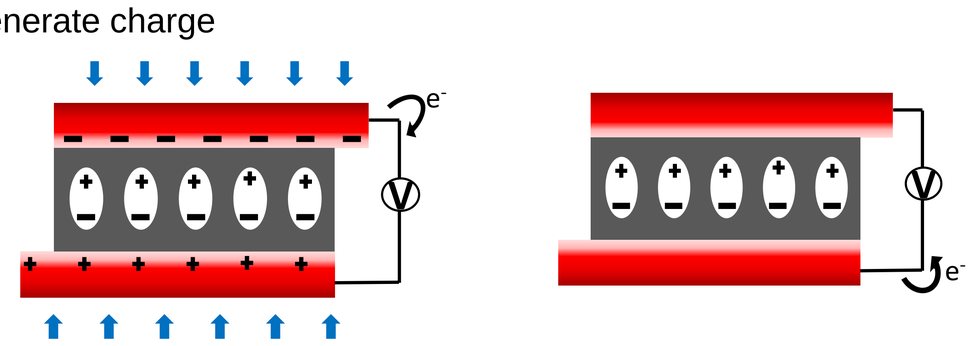
- Highly compliant and patient friendly with regards to Human Centred Design
- High throughput fabrication
- Scalable for large area fabrication
- Biological and Eco friendly



Outstretched 300µm thick ZnO/PDMS film

Transduction Principle

Nanocomposite generators operate with the same basic piezoelectric principles whereby external loads on the polymer matrix transfer force to piezoelectric fillers that generate charge



NCG in compressed state *NCG in relaxed state*

Proof of Concept Device

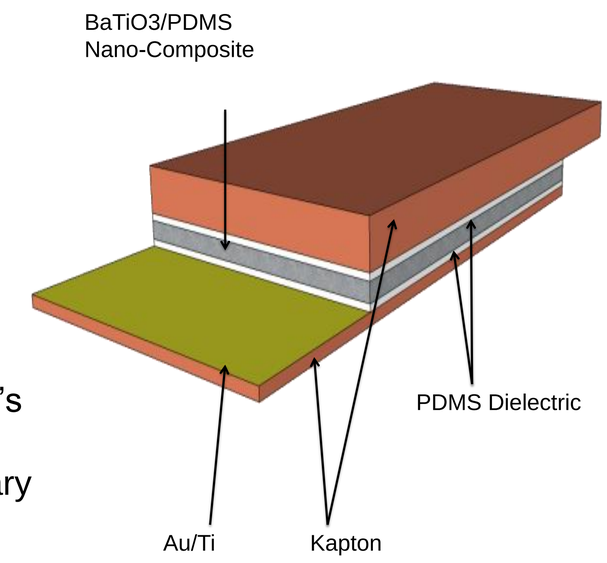
Fabrication

<u>Electrodes</u>

- Sputtering Au/Ti on Kapton films(25µm 500µm)
- Cast PDMS dielectric layer (8µm) on both electrodes

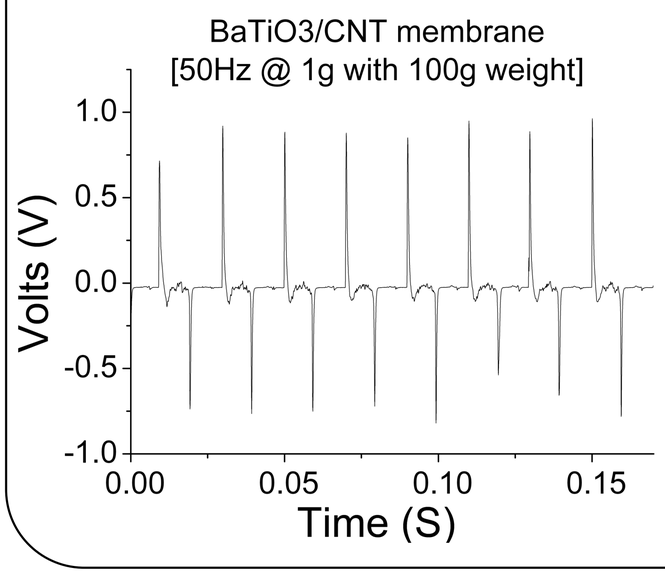
<u>Polymer Composite</u>

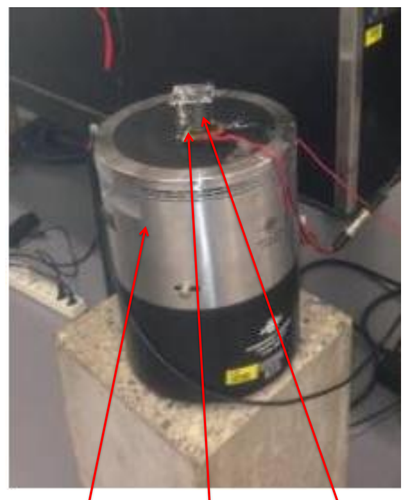
- Rough Mixing of CNT/BaTiO3 NP's in PDMS (1% / 12% / 87%)
- Curing agent addition and planetary mixing (several mixing cycles
- Composite bar casted to 300µm



Characterization

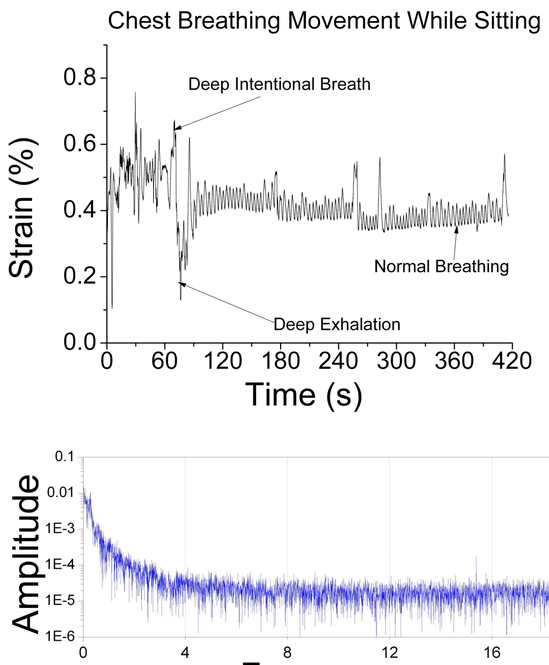
An approximate 1 volt output from the device was seen while under dynamic loading of 1g with 100g 50Hz

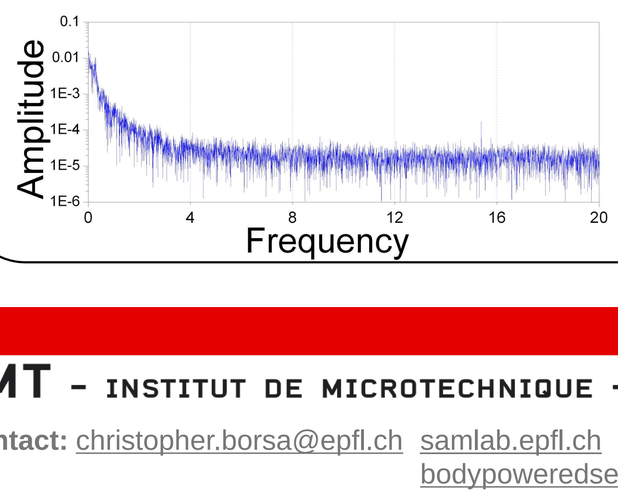




Human Movement Study with Fully Compliant Devices

Human compliance and acceptance is a pivotal factor for the success of any energy harvesting. To Au nanoparticles from Nano Composix this effect fully stretchable state of the art sensors were utilized to measure both chest movements from breathing and shoulder movements during various daily activities.





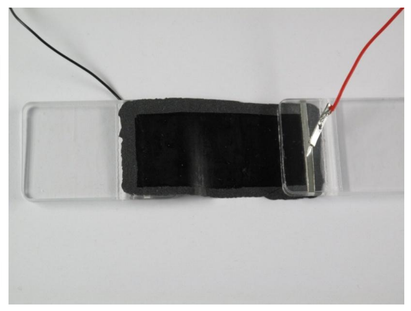
- From these studies it was concluded that the breathing movements occur at approximately 0.3Hz.
- Shoulder movements were found to be very irregular

Outlook

- Established reliable mixing method for NCG active materials
- Fabricated and characterized NCG with foil electrodes
- Fabricated NCG with fully stretchable electrodes

<u>Future Research</u>

- Use of advanced dispersing agents for NP's and CNT's
- Use of low dimensional metallic fillers for dielectric tuning
- 3D stacking and lamination of multiple NCG layers
- Alternative stretchable electrode materials



NCG with fully stretchable carbon black electrodes

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