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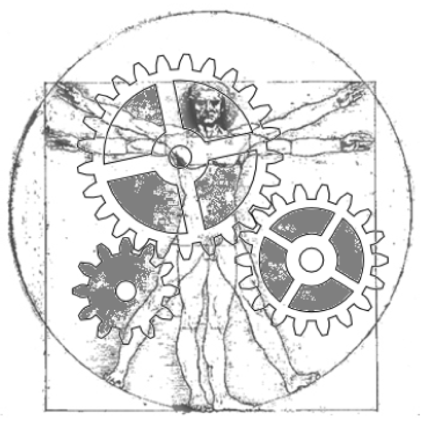
BodyPoweredSenSE RTD 2013

FNSNF

Flexible On-Body Piezoelectric Energy Harvesting



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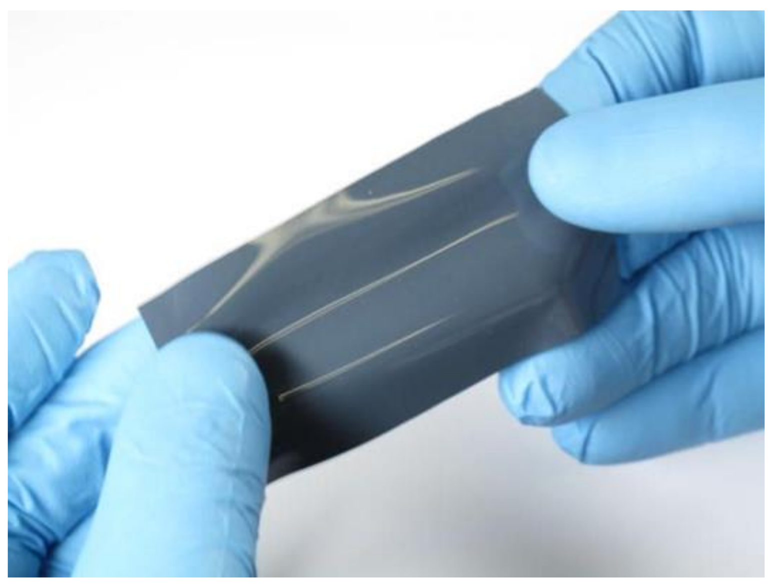
Introduction

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?

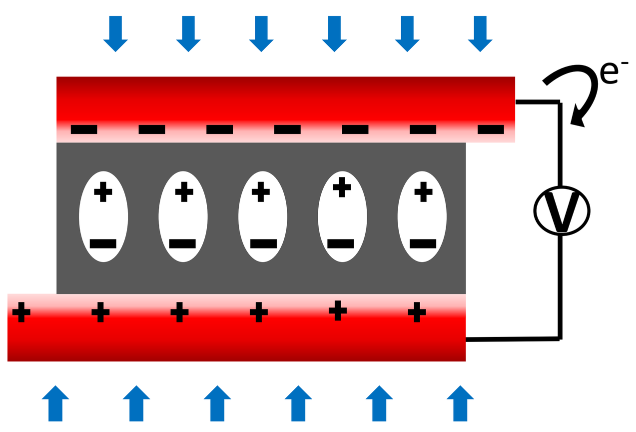
- Highly compliant and patient friendly with regards to Human Centred Design
- High throughput fabrication
- Scalable for large area fabrication
- Biological and Eco friendly



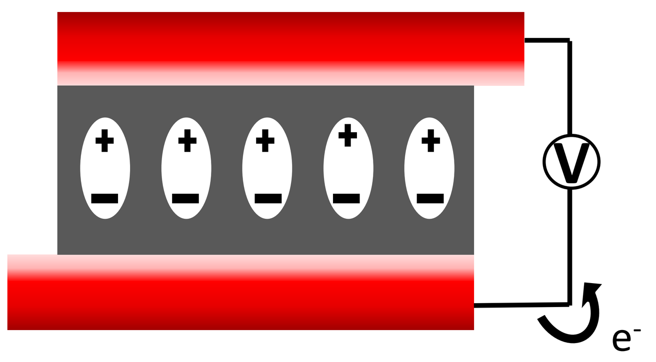
Outstretched 300µm thick ZnO/PDMS film

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



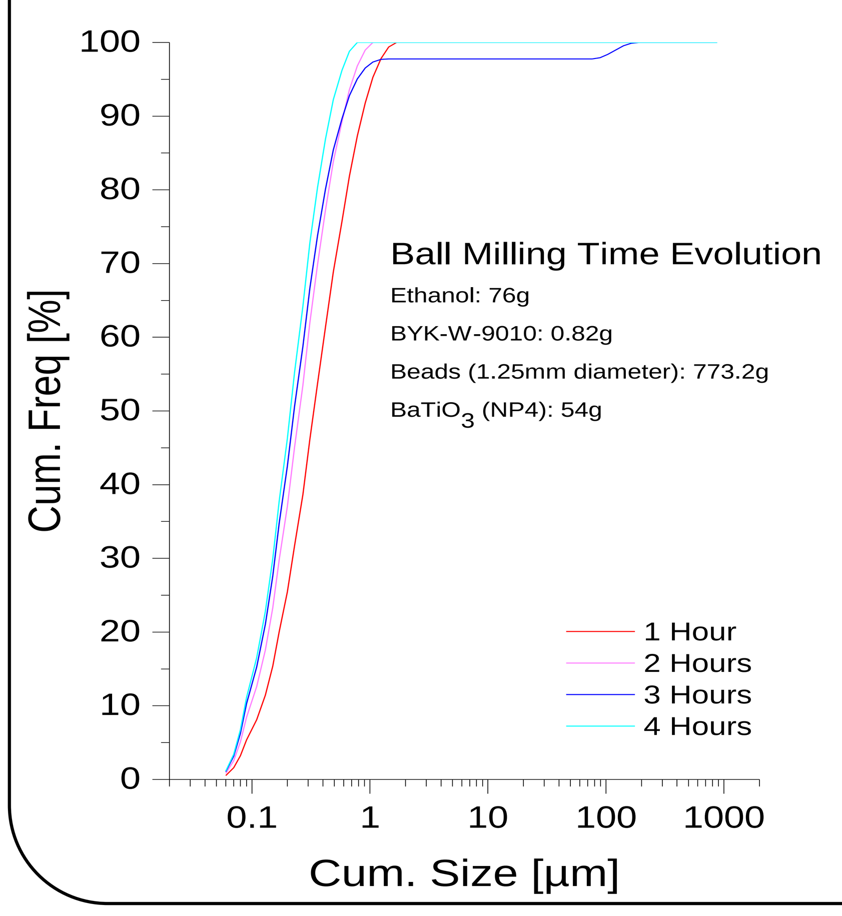
NCG in compressed state



NCG in relaxed state

Composite Development

Development of Large area piezoelectric membranes calls for the use of readily available and saleable piezoelectric fillers such $BaTiO_3$. With most of these materials being highly agglomerated as seen in the below, high energy attrition milling is required to obtain a homogeneous dispersion.



After milling, $BaTiO_3$/ethanol dispersion is transferred into toluene via ultracentrifugaion. Resulting $BaTiO_3$/toluene dispersions were stable with a 3 hour working window.

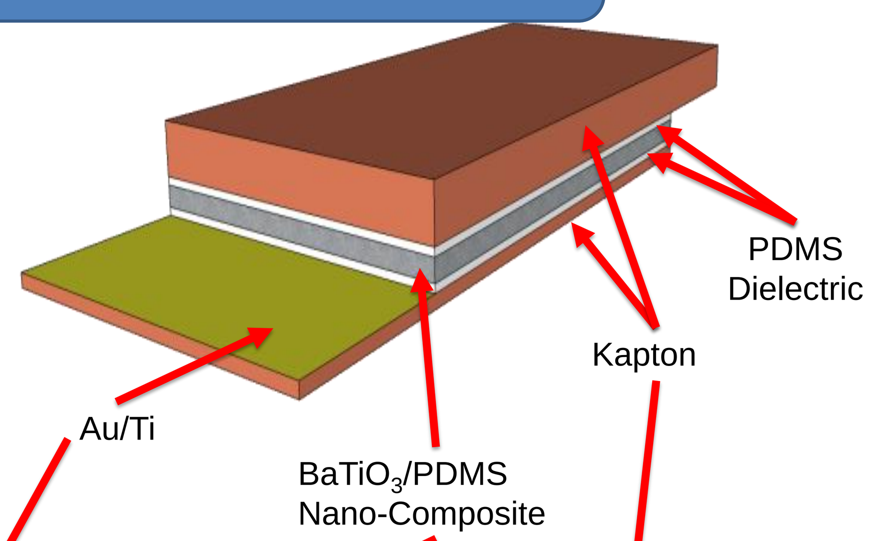
$BaTiO_3$/toluene dispersion after 24hours

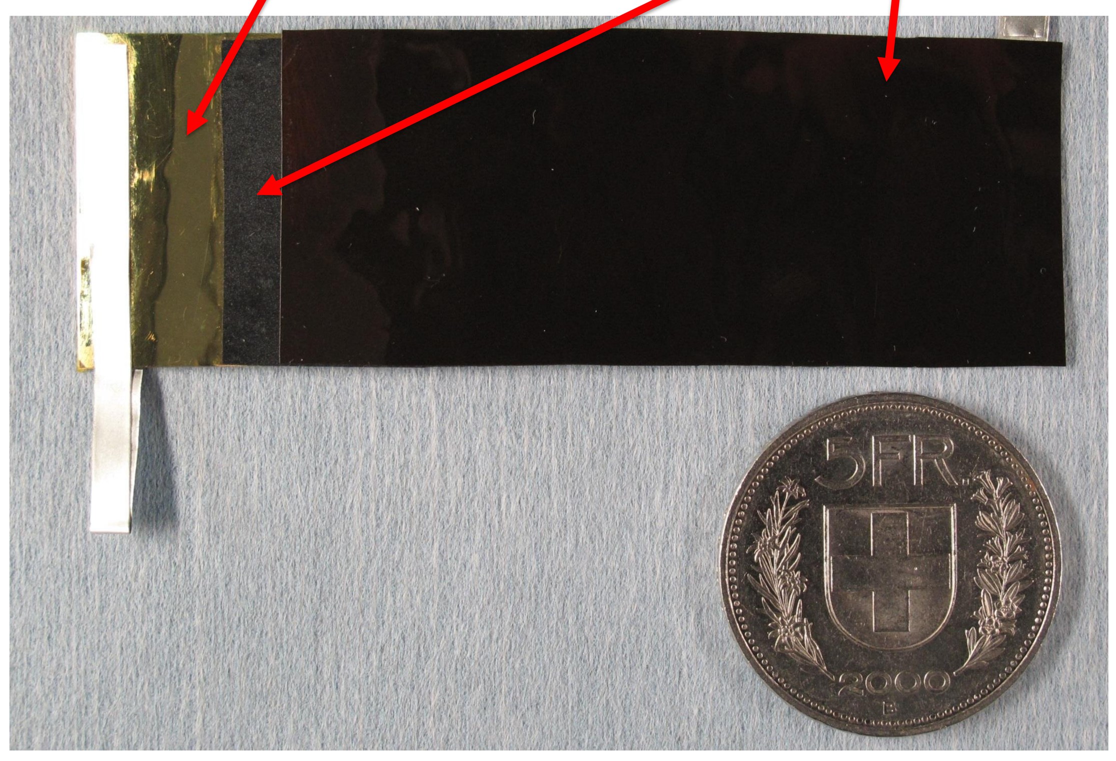
Final CNT/NP/PDMS mixture

Materials Characterization

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

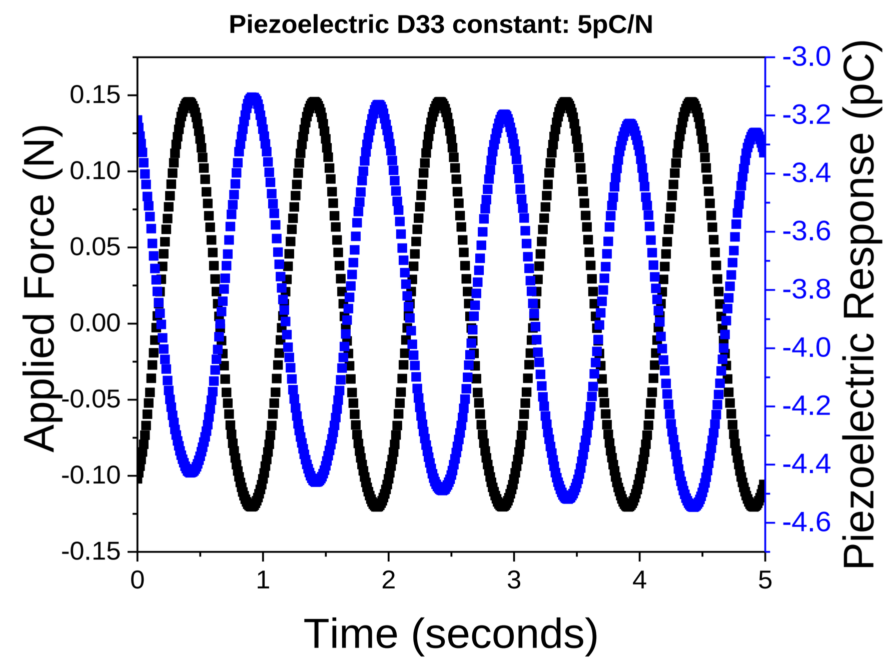
Polymer Composite
- Rough Mixing of CNT/$BaTiO_3$ NP's in PDMS (1% / 12% / 87%)
- Curing agent addition and planetary mixing (several mixing cycles
- Composite bar casted to 300µm

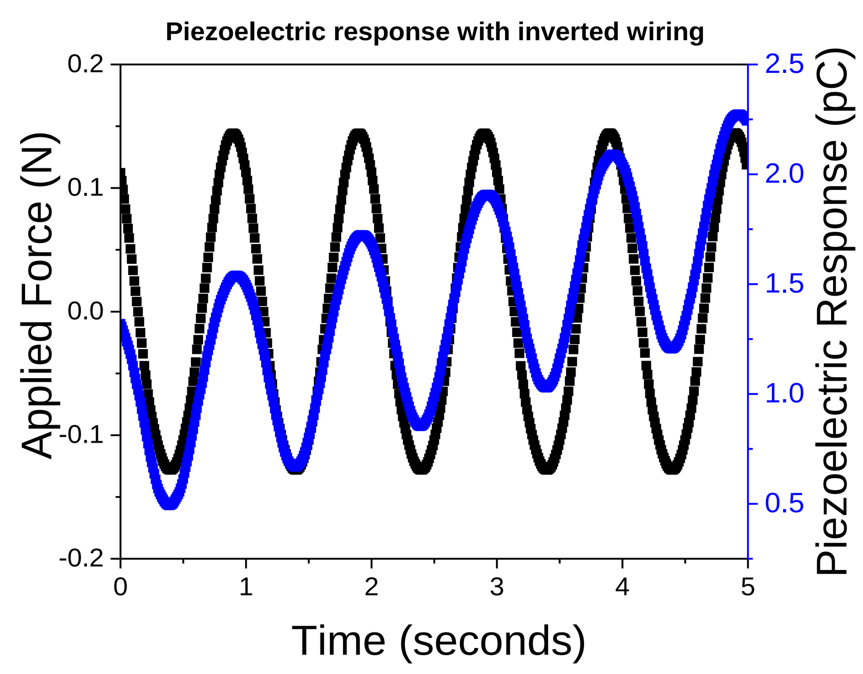




Characterization

The samples seen to the right were tested via the berlincourt method where a known input force is imparted on the sample and closed circuit piezoelectric charge is then measured. Novel samples were to have D_{33} piezoelectric coefficient of 5pC/N, and successfully passed the switching-polarity test as seen below.





Outlook

Future Research
- Use of low dimensional metallic fillers for dielectric tuning
- Impedance spectra study to investigate interfacial polarization effects
- 3D stacking and lamination of multiple NCG layers
- Alternative stretchable electrode materials
  - Printable silver inks

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