# Properties of Spongy Structured $BaTiO_3$ Prepared by R.F. Magnetron Sputtering for Energy Harvester

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A sustainable energy-harvesting technique, which can transfer various forms of energy from the surrounding environment into electricity, could be an alternative to remedy the shortcomings of traditional battery technology [1-3]. New piezoelectric and triboelectric materials for energy harvesting are being widely researched to reduce their processing cost and complexity and to improve their energy conversion efficiency. In this study, $BaTiO_3$ films of various thickness were deposited on Ni foams by R.F. magnetron sputtering to study the piezoelectric and triboelectric properties of the porous spongy structure materials. Then piezoelectric nanogenerators (PENGs) were prepared with spongy structured $BaTiO_3$ and PDMS composite. The output performance exhibited a positive dependence on the thickness of the $BaTiO_3$ film, pushing load, and poling. The PENG output voltage and current were 4.4 V and 0.453 μA at an applied stress of 120 N when poled with a 300 kV/cm electric field. The electrical properties of the fabricated PENG were stable even after 5,000 cycles of durability testing. The triboelectric nanogenerators (TENGs) were fabricated using spongy structured $BaTiO_3$ and various polymer films as dielectrics and operated in a vertical contact separation mode. The maximum peak to peak voltage and current of the composite film-based triboelectric nanogenerator were 63.2 V and 6 μA, respectively. This study offers new insights into the design and fabrication of high output nanogenerators using spongy structured materials.

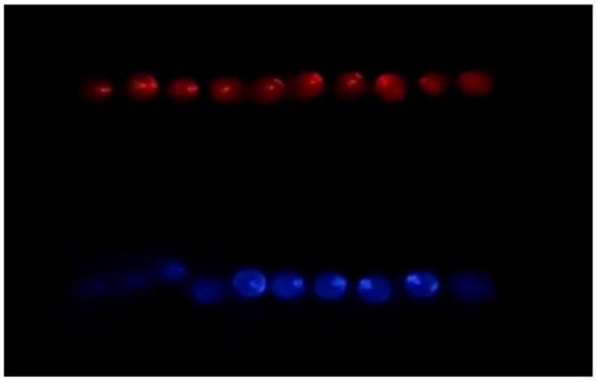

Figure 1. Illumination of red and blue LEDs at a load of 50 N

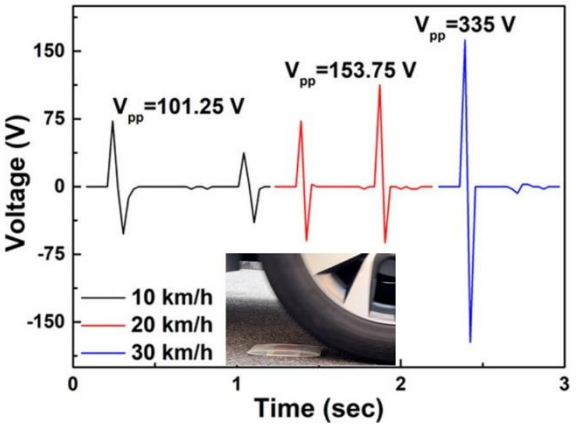


Figure 2. Output voltage generated at different speeds of vehicle.

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[2] T. Li and P. S. Lee, Small Struct., **3**, 2100128 (2022).
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# Supplementary information

Table 1. Sputtering conditions for $BaTiO_3$ film preparation.

| **Sputtering condition** | |
|---|---|
| Substrate | Ni foam |
| Target | $BaTiO_3$ (99.99%) |
| Target-substrate distance | 100mm |
| Base pressure | $5x10^{-6}$torr |
| Working pressure | 10mTorr |
| R.F. Power | 150~210W |
| Deposition time | 3h |
| Substrate Temperature | Room temperature |

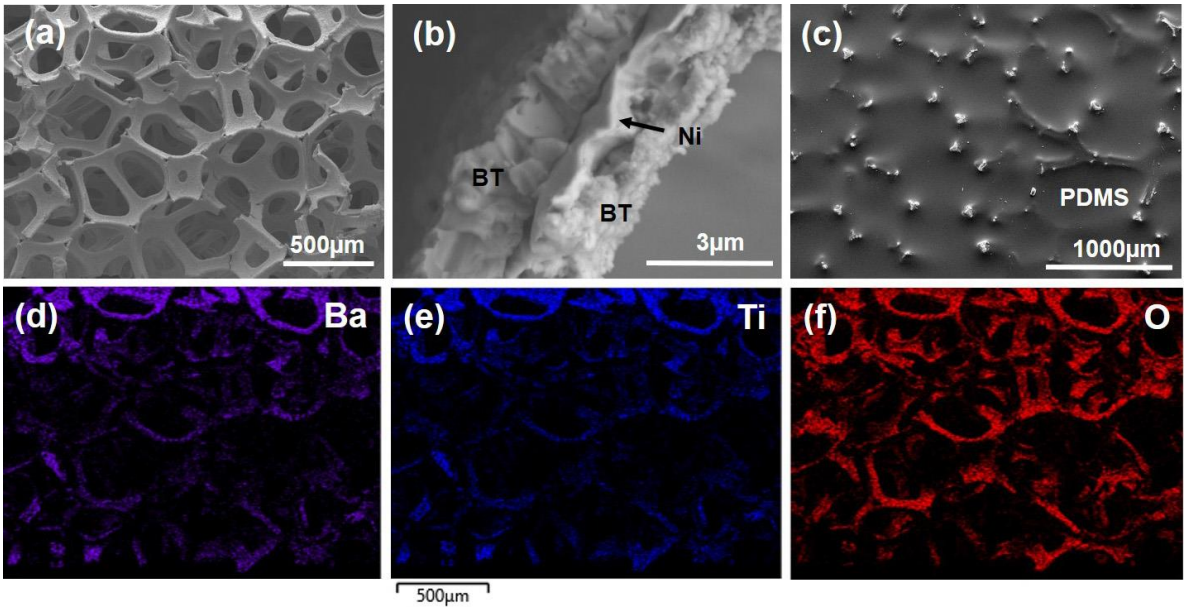


Figure 3**.** (a) SEM image of $BaTiO_3$ films deposited on Ni foam, (b) Enlarged cross-sectional image $BaTiO_3$ foams, (c) $BaTiO_3$ foams filled with PDMS and (d-f) EDS mapping images of (a).