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Prototyping of a Rotary Triboelectric Nanogenerator for Power at Sea

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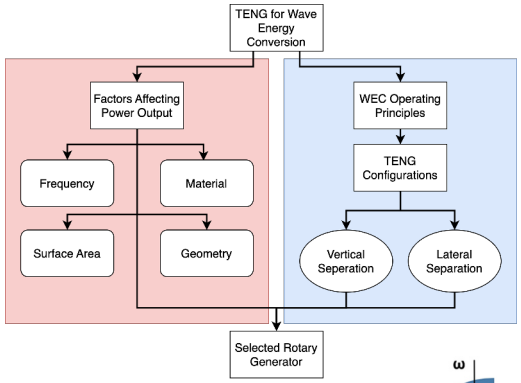
Introduction

- Wave energy is underutilized globally[1].
- Powering remote ocean devices is expensive and difficult[2].
- New methods of power generation must be explored to make wave energy commercially viable.

Triboelectric nanogenerators (TENG) use moving static charges to generate electricity.

TENGs can exhibit a low cost of manufacture, are lightweight, and can decouple the high-force low-frequency of waves with low-force, high-frequency agitations.

Down-Selection of TENG configuration



Selected rotary TENG:

- Stator collects electricity from electrostatic induction on its *metal surface*.
- Rotor collects charges on its *insulating surface* via friction element.

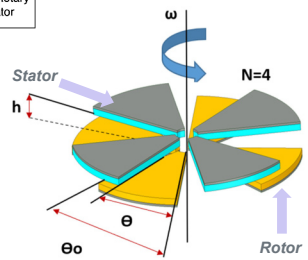


Fig 1. A prototypical rotary TENG[4]

References

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2. C. Rodrigues, D. Nunes, D. Clemente, N. Mathias, J.M. Correia, P. Rosa-Santos, F. Taveira-Pinto, T. Morais, A. Pereira, and J. Ventura, Energy Environ. Sci. 13, 2657 (2020).
3. T. Jiang, X. Chen, C.B. Han, W. Tang, and Z.L. Wang, Adv. Funct. Mater. 25, 2928 (2015).
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Experimental Setup

Fig 2. Left: PCB copper stator. Right: PTFE rotor.

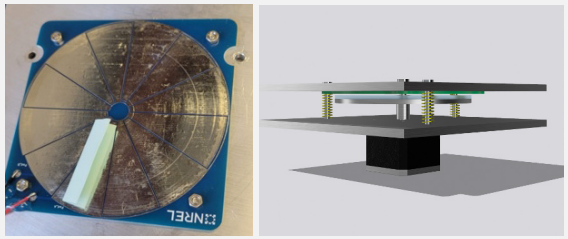


Fig 3. Left: Stator with friction element. Right: schematic of testing apparatus.

- Procured insulating films at different thicknesses.
- Manufactured and tested rotors by varying number of wedges, film thickness and spacing of wedges.

Results

- Found 0.127 mm PTFE with 6 sectors gave best results.
- Charge saturates on the rotor after many revolutions.
- Rotor found to retain charges after removing friction element.

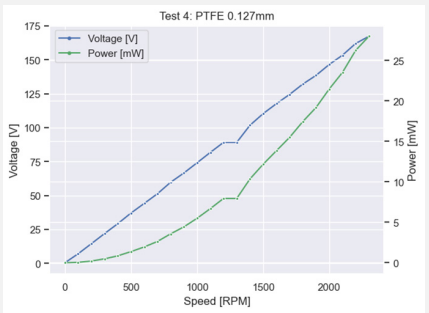


Fig 4. Performance of 0.127 mm PTFE rotor at 1 MΩ.

Results

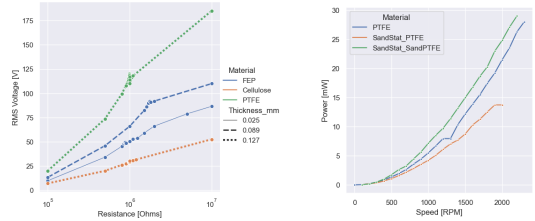
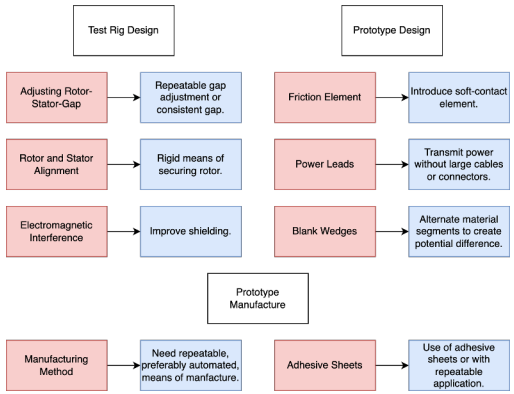
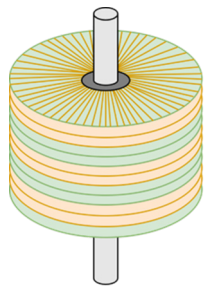


Fig 5. Left: Performance of various materials and thicknesses. Right: Performance of sanded 0.127 mm PTFE rotor at 1 MΩ.

Sanding of stator and rotor slightly improves output, which is attributed to the removal of the circuit board coating and exposure of the copper layer.

Future Work and Conclusions





Several thin electrodes take advantage of printed circuit board (PCB) precision manufacturing.

Stator PCBs mounted to shaft. Rotor PCBs mounted to bearings in pairs.

Stator (S) and rotor (R) discs alternate in pairs. i.e. S - R - R - S

Rotor consists of flexible PCB, which contacts stator at rest and is centrifugally decoupled when spinning.

Fig 6. Proposed design of stacked TENG

Acknowledgements
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