Piezoelectric Nanogenerator for Energy Harvesting and Sensory Applications: Introducing a Smart Helmet

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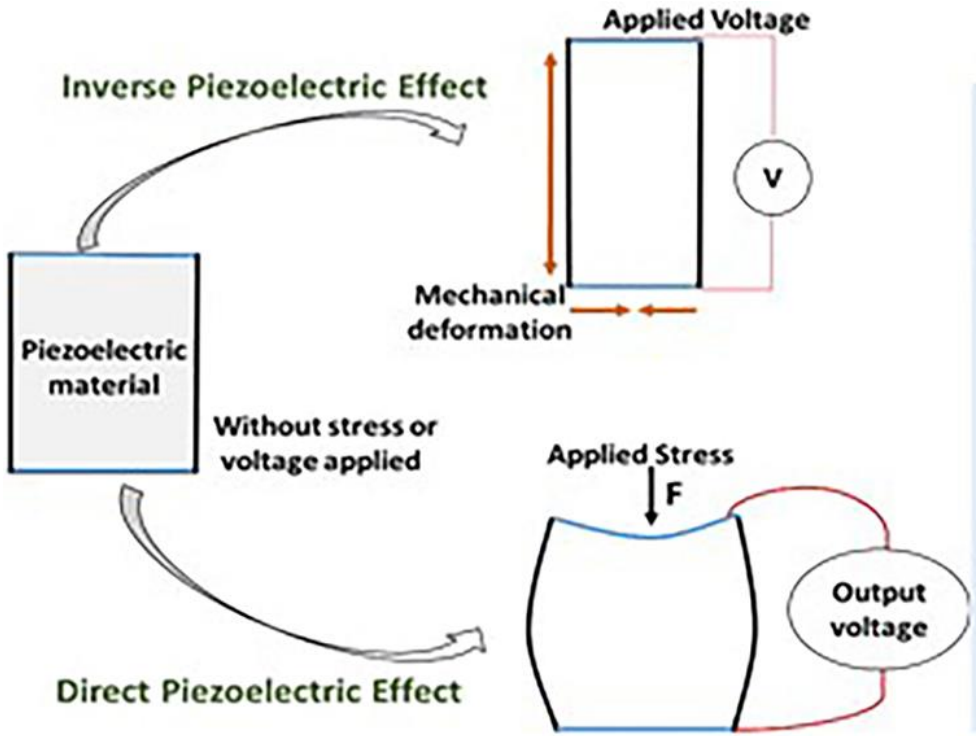
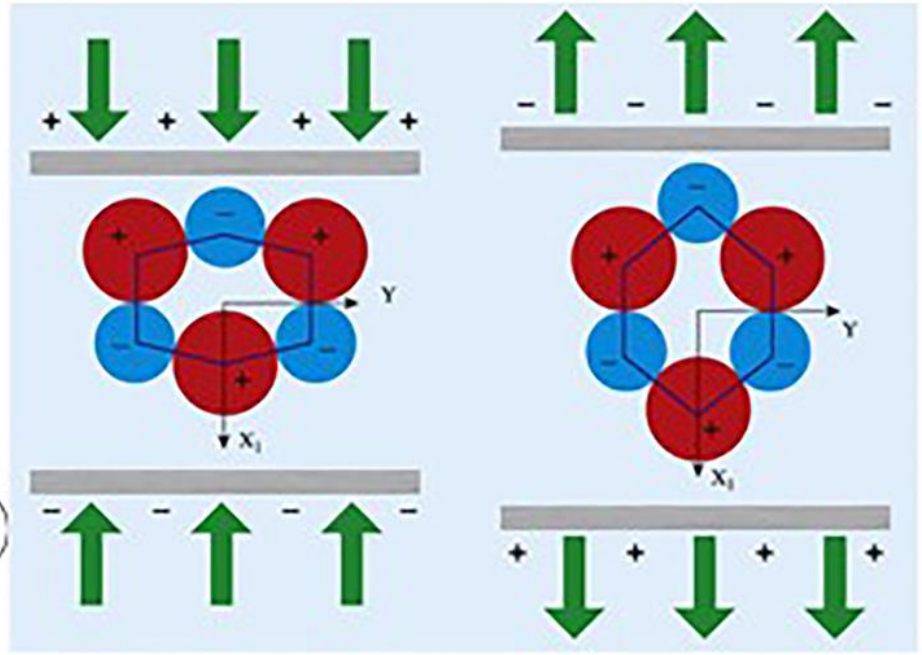
Abstract

- Piezoelectric sensors have widespread of functionality, therefore they are highly desirable
- We propose an aluminum-doped zinc stannate ($ZnSnO_3$) piezoelectric nanogenerator with exceptional output characteristics
- The low-temperature solution method was employed, which contributes to the device's enhanced piezoelectricity
- $ZnSnO_3$ was doped with 1 wt% to 5 wt% of aluminum (Al) nano particles, the amount that was found to be the most optimal respect to the electrical output is 2 wt%
- The nanogenerator achieved an average open circuit voltage of 80 V to 160 V for frequency 60 BPM to 240 BPM, maximum short circuit current found 25 µA, and power density of 1.0-1.5 w/m2
- This is an unprecedented electrical output compared to previous $ZnSnO_3$-based piezoelectric nanogenerators

Piezoelectric Mechanism





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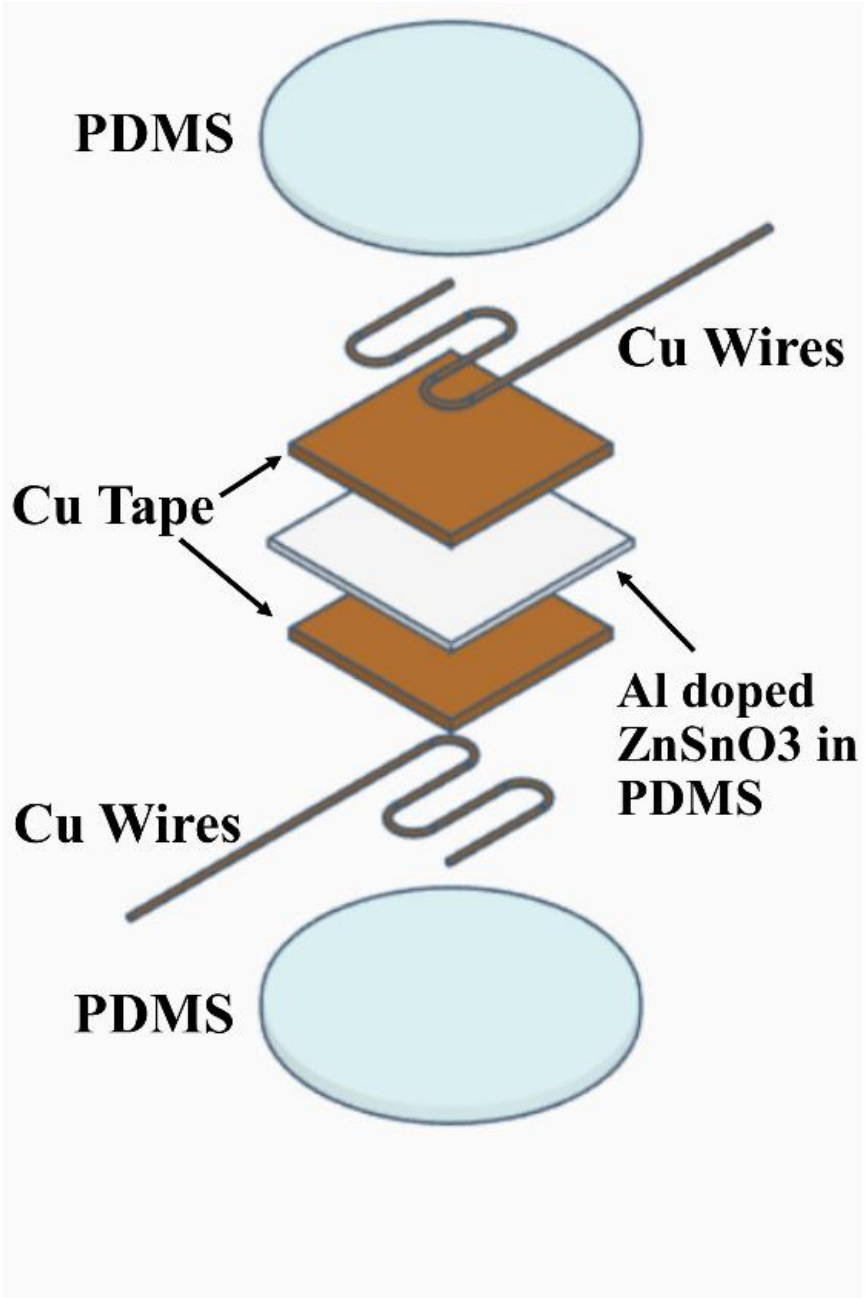
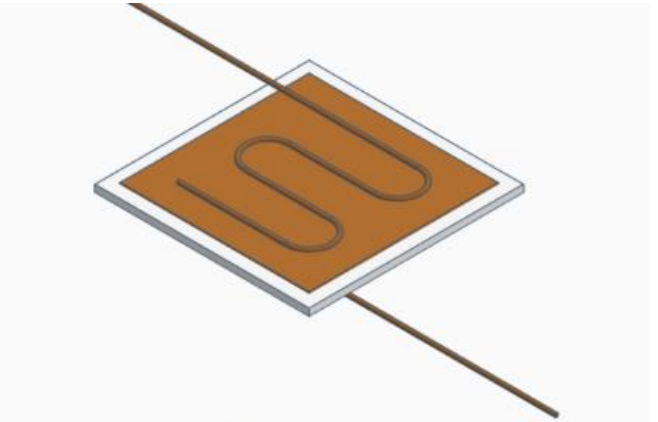
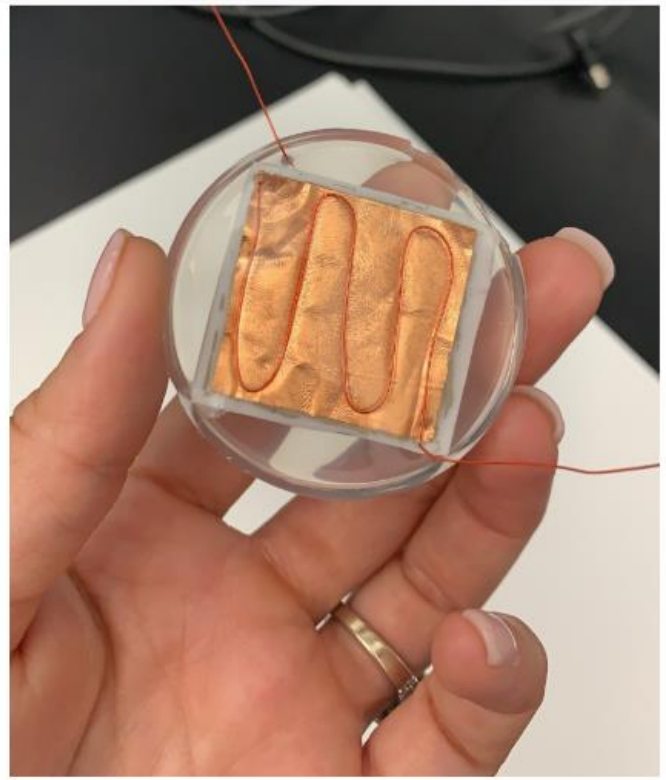
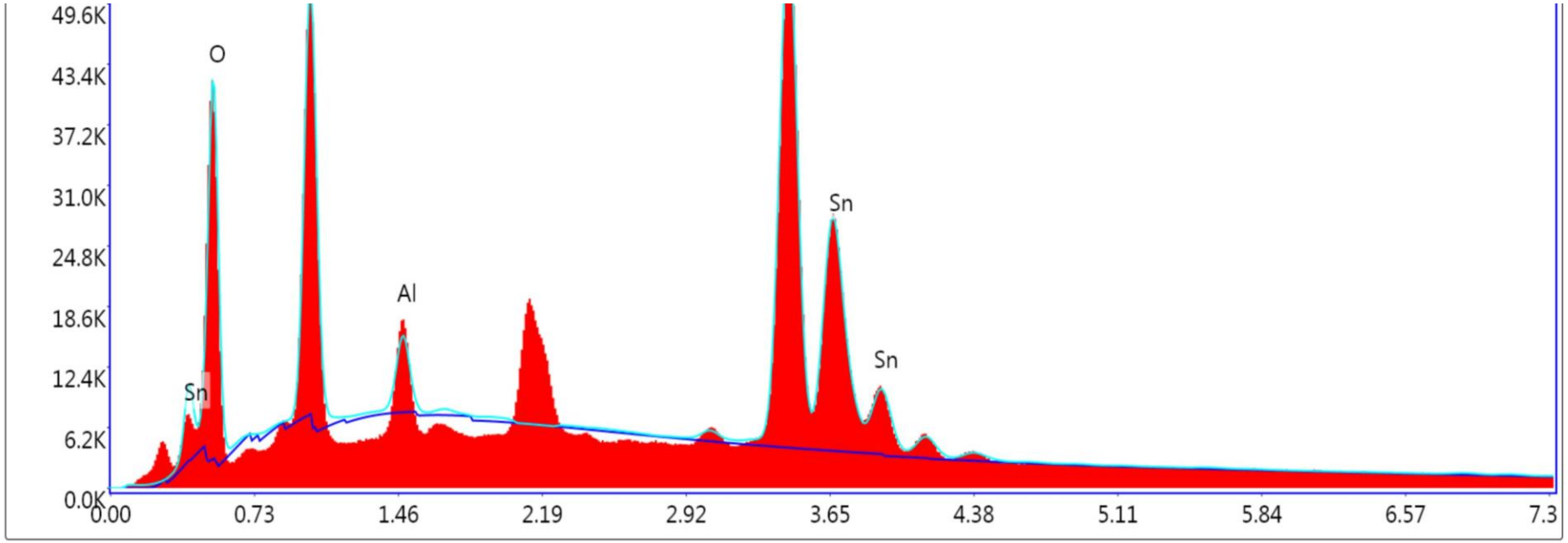
Schematic of Nanogenerator





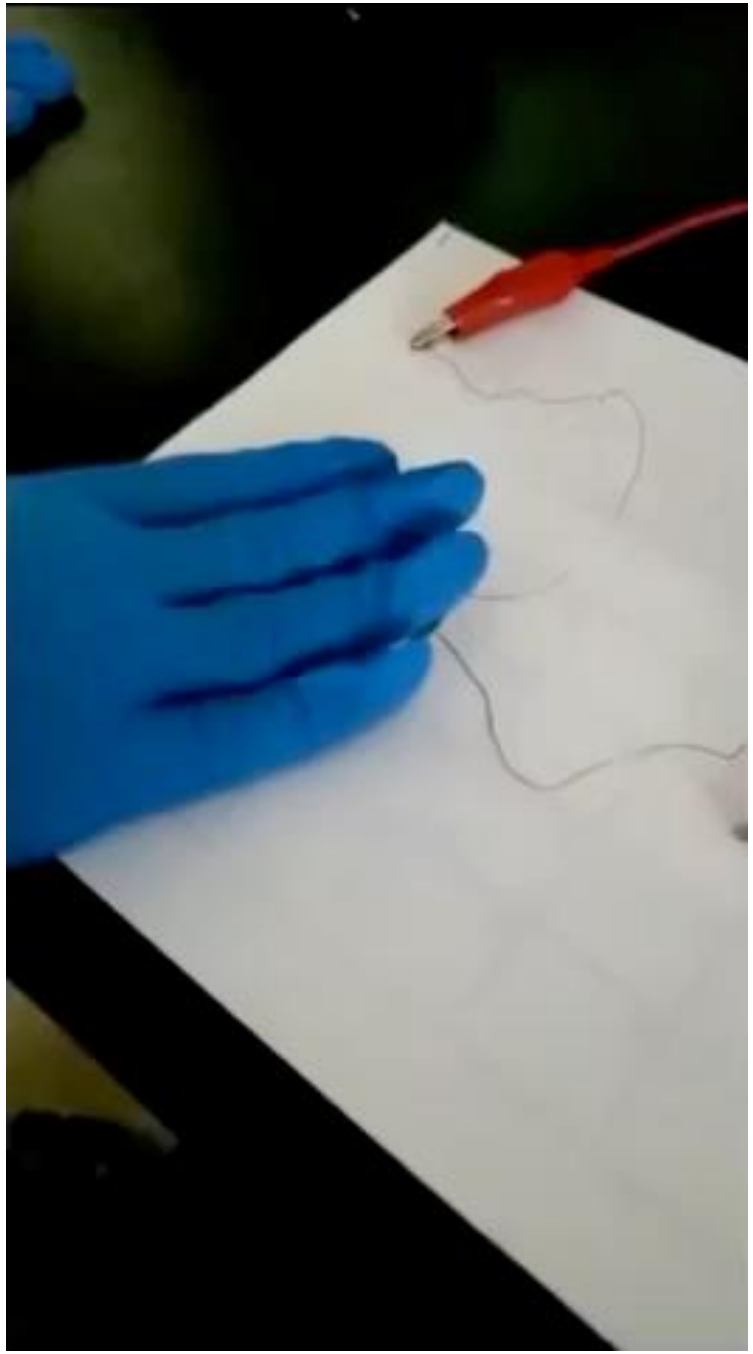




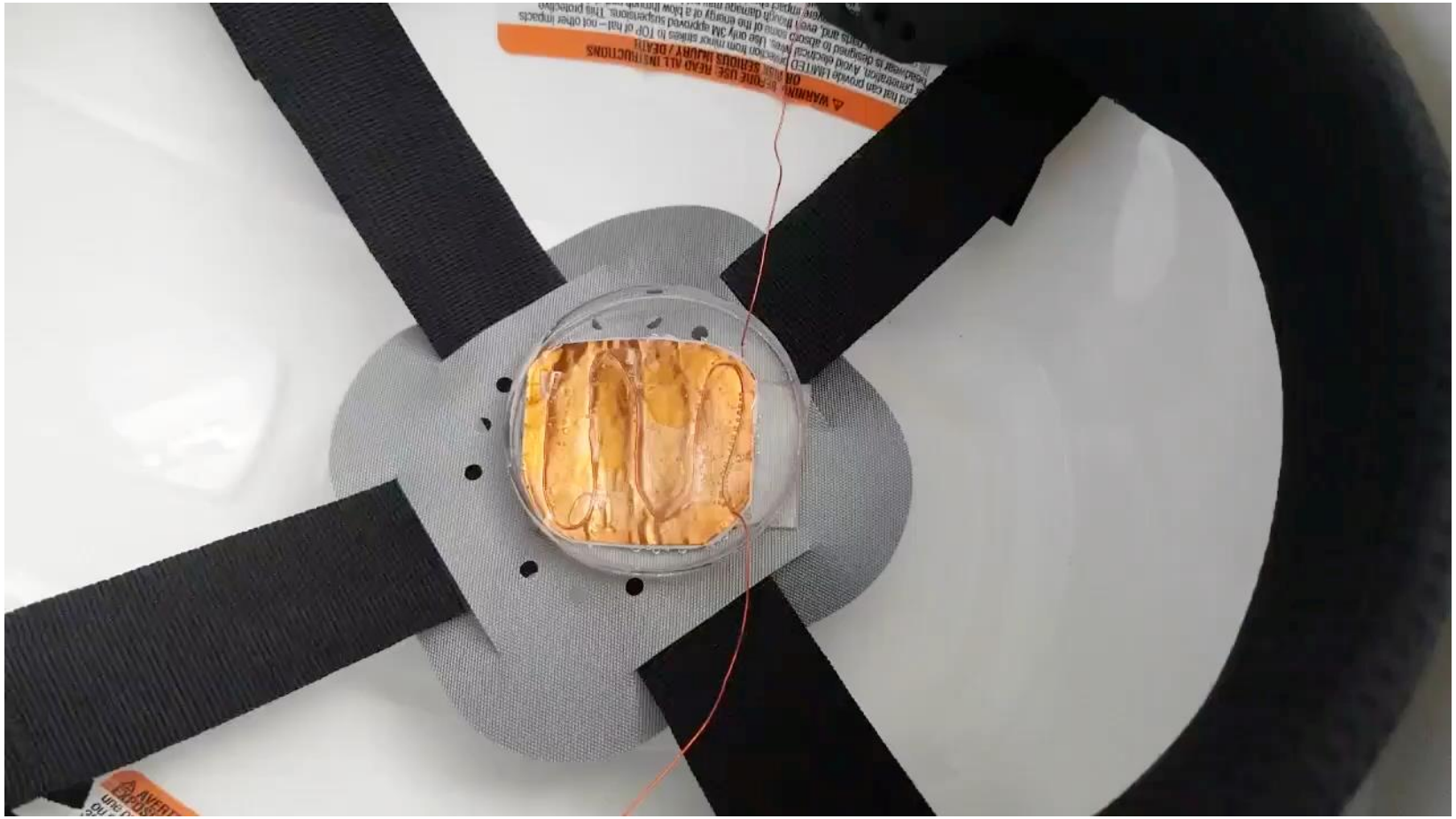
Element	Weight %	Atomic %	Error %	K Ratio	Z	A	F
O K	9.47	37.93	7.45	0.0622	1.4602	0.4495	1.0000
Zn L	22.04	21.61	6.71	0.1245	1.0617	0.5319	0.9998
Al K	1.90	4.51	7.48	0.0135	1.2931	0.5499	1.0040
Sn L	66.59	35.95	2.68	0.6045	0.9012	1.0072	1.0002

Characterization: EDS Mapping & EDAX Composition Analysis

Finger Tapping Test



Power Generation by Smart Helmet



Wireless Sensory Application of Smart Helmet

Applications of the Nanogenerator

- Renewable source of power generation
- Sensory applications
- Able to detect human movement
- Transmits signals remotely
- Self-powered device
- Can be utilized in heavy industry, as health monitoring sensors, and possible gadgets for the Armed Forces

Future Perspective

- Flexible, durable, and an alternative source of renewable energy
- Wearable healthcare device
- Prospective in vitro/in vivo biomedical applications
- Due to high size to response ratio, it is can be an alternative for conventional medical devices
- Self-powering feature, for possible prospect in Internet of Things

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Any Questions?