SELF-SUSTAINING LOW-COST AND WIDELY AVAILABLE ENERGY HARVESTING AND SENSING DEVICES FOR USE IN MUSEUM ENVIRONMENTS

UMBC

U-RISE

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Introduction

In art preservation, low-cost environmental sensors can be powered by energy harvesting (thermoelectrics, triboelectrics) to aid in monitoring art stability.

Thermoelectric devices convert waste heat sources in museum environments to electric energy.

Triboelectrics, made of low-cost materials from thermoelectrics manufacturing, were investigated as a secondary energy harvesting source and binary sensors for art movement.

This work investigates methods of incorporating 2D Ti_3C_2 (MXene) nanosheets into $Bi_{0.5}Sb_{1.5}Te_3$ (BST) by varying pH levels and applied uniaxial pressures.

This study is the first step in the development of battery-operated sensors for the museum environment with reduced maintenance and energy consumption.

Materials

Thermoelectric Energy Harvester

- $Bi_{0.5}Sb_{1.5}Te_3$ (BST) powder
- 1ml Dimethylsulfoxide (DMSO)
- 3 Drops Hydrochloric acid (HCl)
- 500µL MXene

Triboelectric Sensor

- 12in x 16in cardboard
- 11.5in x 1.5in Al foil electrode
- 5 strips of Kapton tape
- Python Controlled Multimeter

Methodology and Results

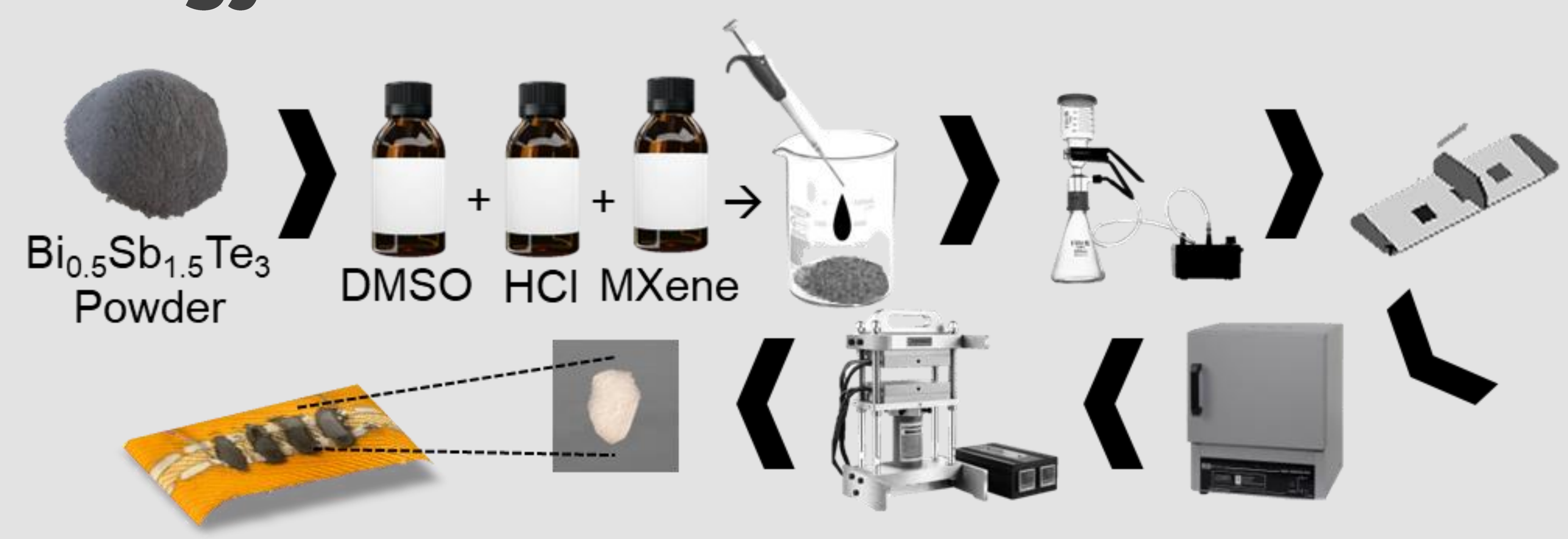

Figure 1. Methodology of Thermoelectric Film and Device Fabrication

Thermoelectric materials, such as BST, and composites generates increasing power with higher electrical conductivity (current) and Seebeck coefficient (voltage).

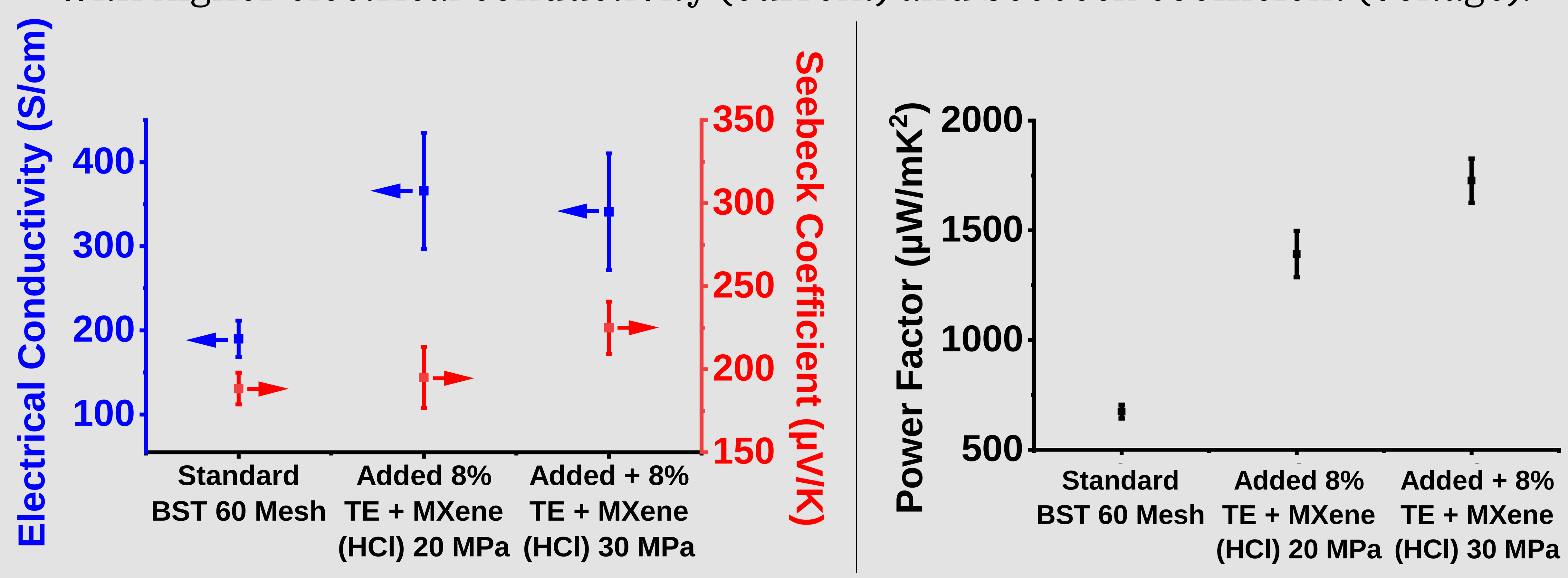

Figure 2. Thermoelectric Electrical Conductivity and Seebeck Coefficient Outputs (left) and Power Factor (Right) With Manufacturing Techniques

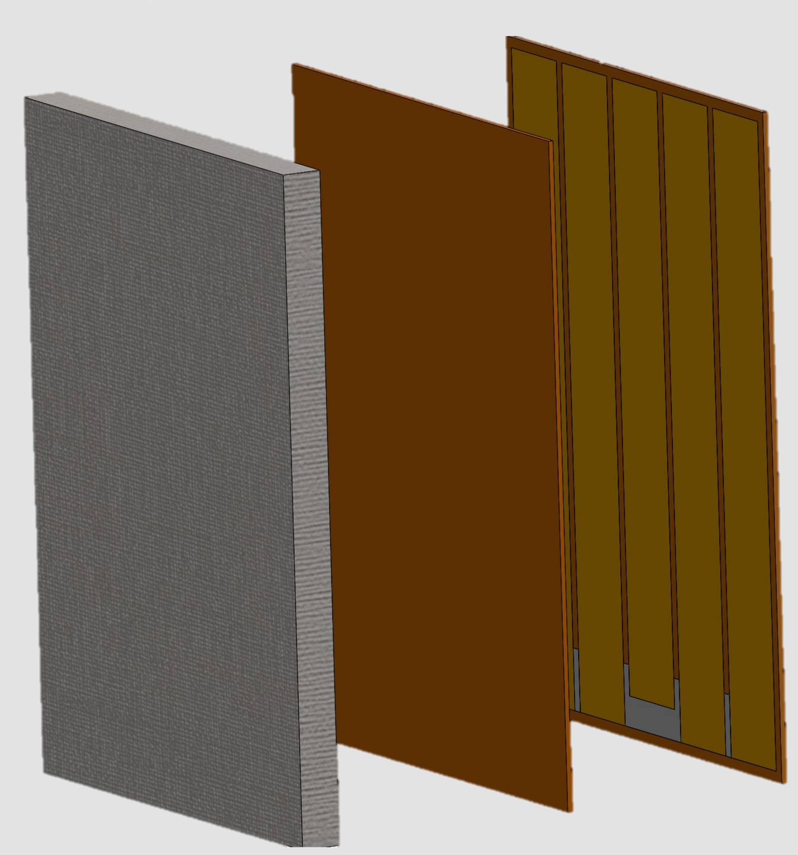

Figure 3. Triboelectric Device Composition

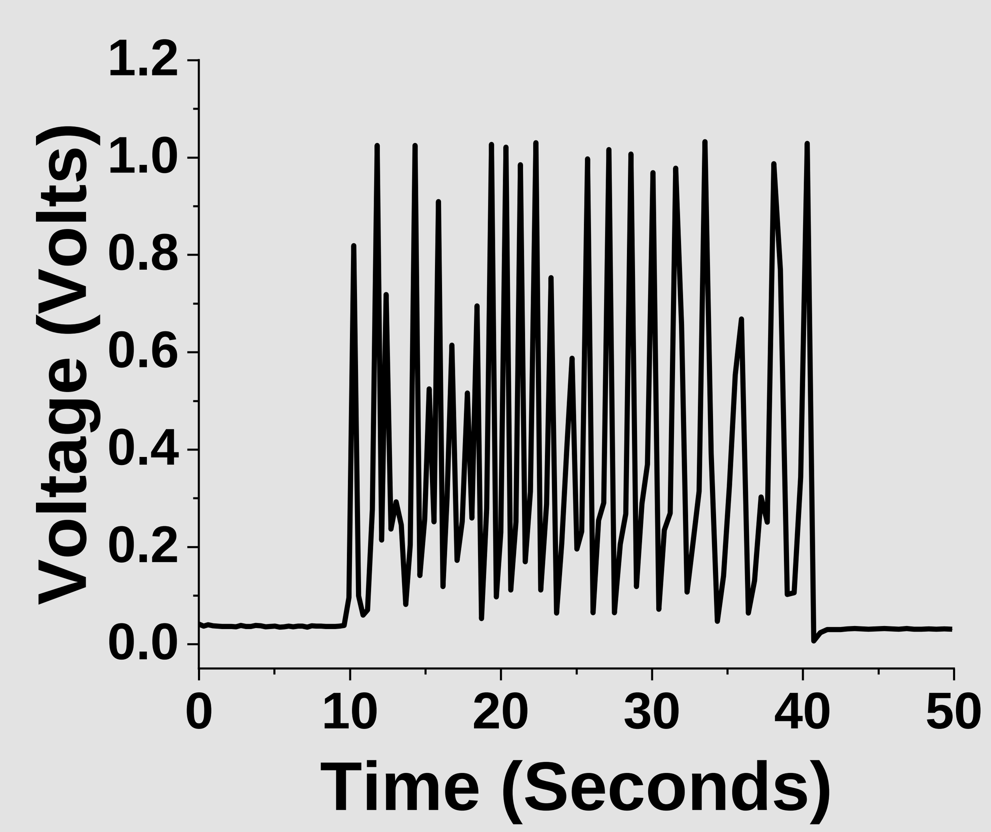

Figure 4. Triboelectric Device Voltage Output Under Load

Conclusion

HCl + MXene incorporation into BST based thermoelectric films leads to no visible phase separation and an over doubled power factor of 1726.5 µW/mK² by creating oppositely charged zeta potentials at low pHs that allow for MXene/BST bonding under applied pressure.[1,2]

A triboelectric motion sensor was fabricated using waste materials from thermoelectric manufacturing that are apart on the triboelectric series and can detect disturbances to art by generating 1.1V peaks above noise.[3]

These devices may allow for low-cost and widely available sensors for future preventative art conservation.

References

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