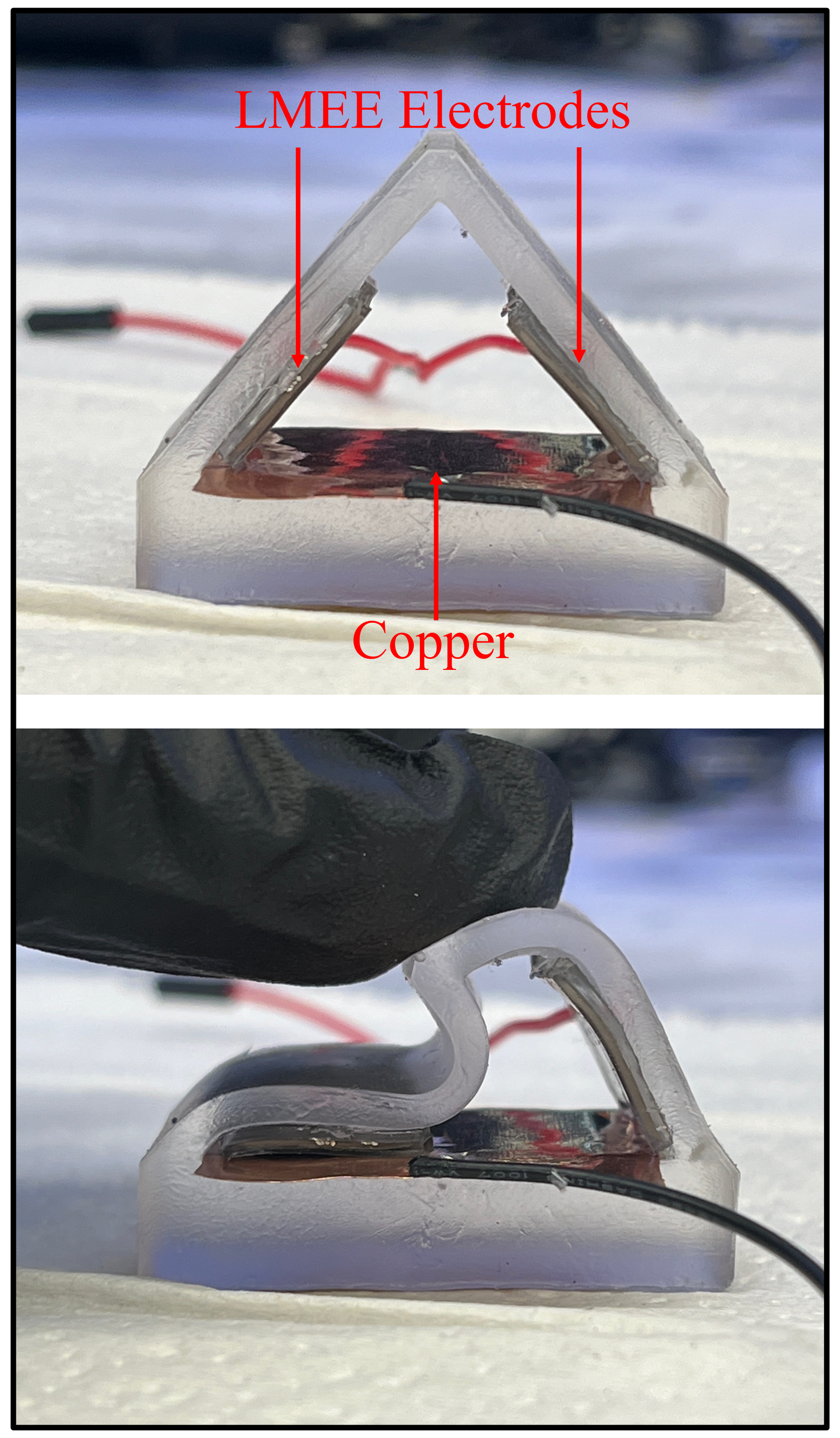
Triboelectric Energy Harvesting

Matthew Dohmen, Eric J. Markvicka, Ph.D.

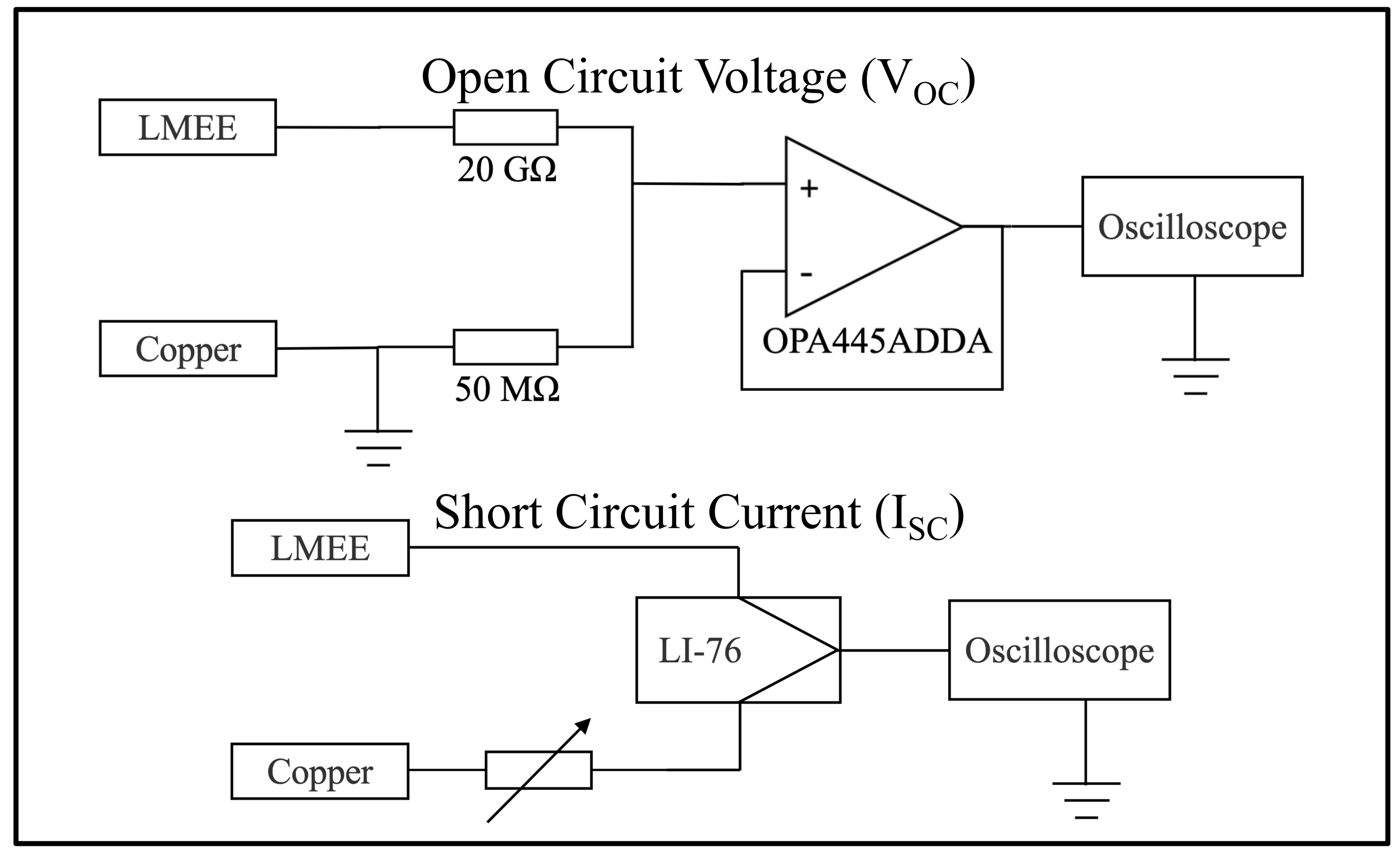
Significance and Background

The goal of this research is to create a wearable energy-harvesting system. This system could aid in the effort to minimize the use of batteries in wearable electronics, like health-monitoring devices.

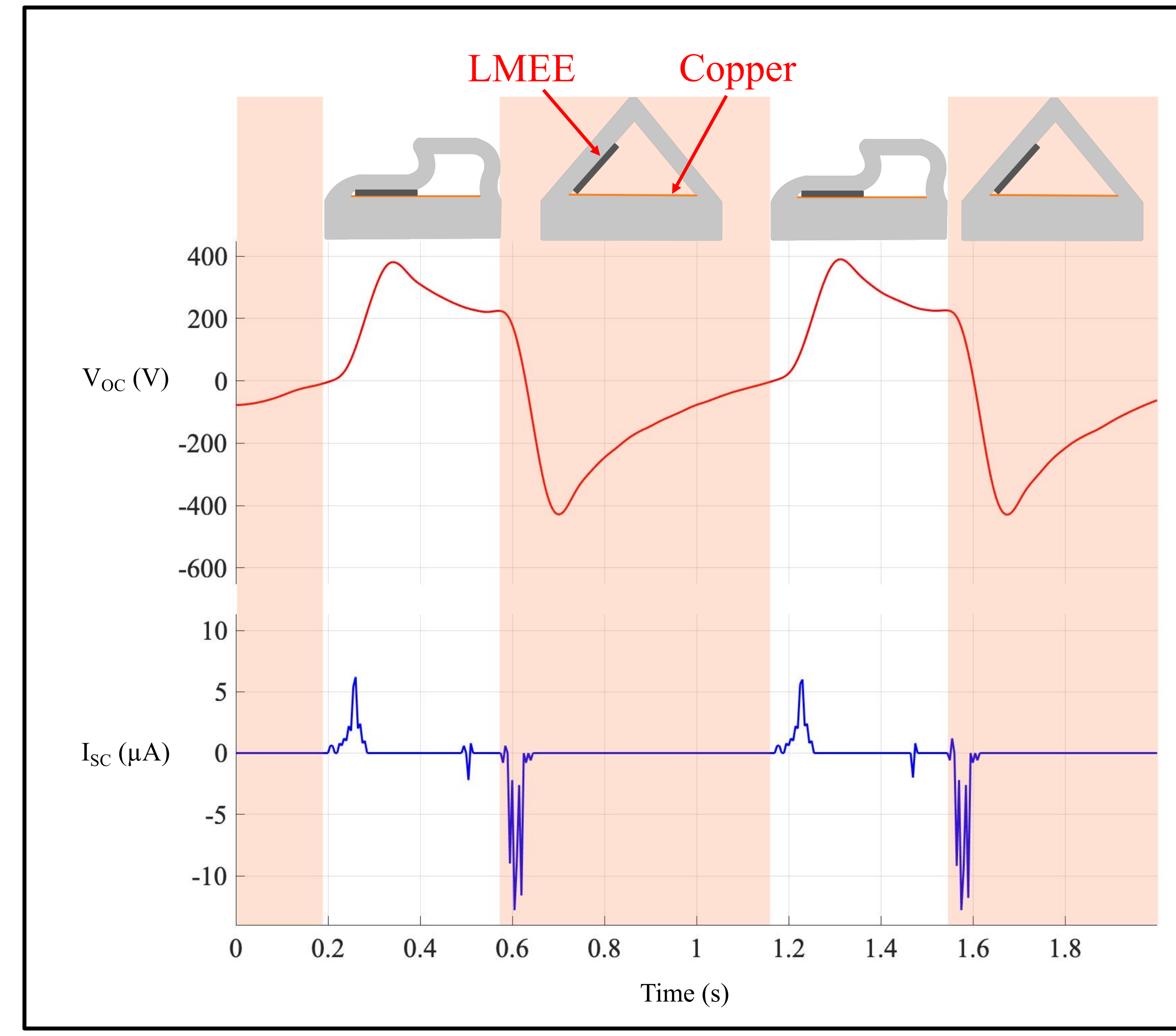
Liquid-metal embedded elastomers (LMEE) have a unique combination of properties – they are highly elastic while maintaining high electrical and thermal conductivity. By taking advantage of these properties and the triboelectric effect, a triboelectric nanogenerator was created, capable of harvesting energy otherwise lost through motion.



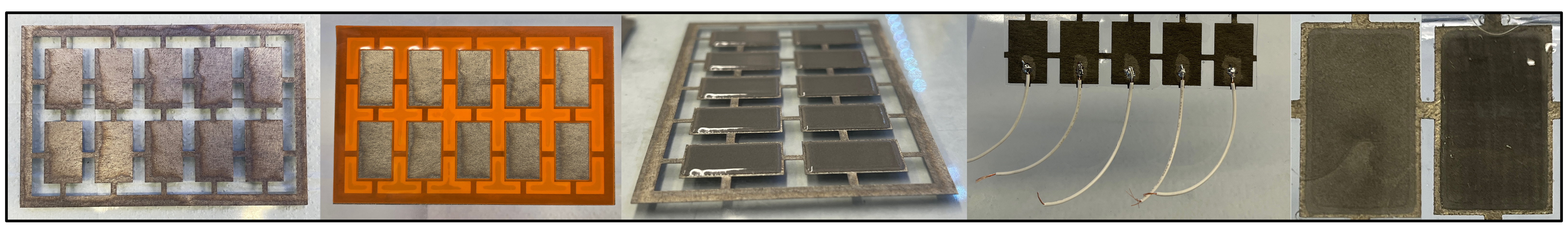
Characterization of Triboelectric Nanogenerator (TENG)



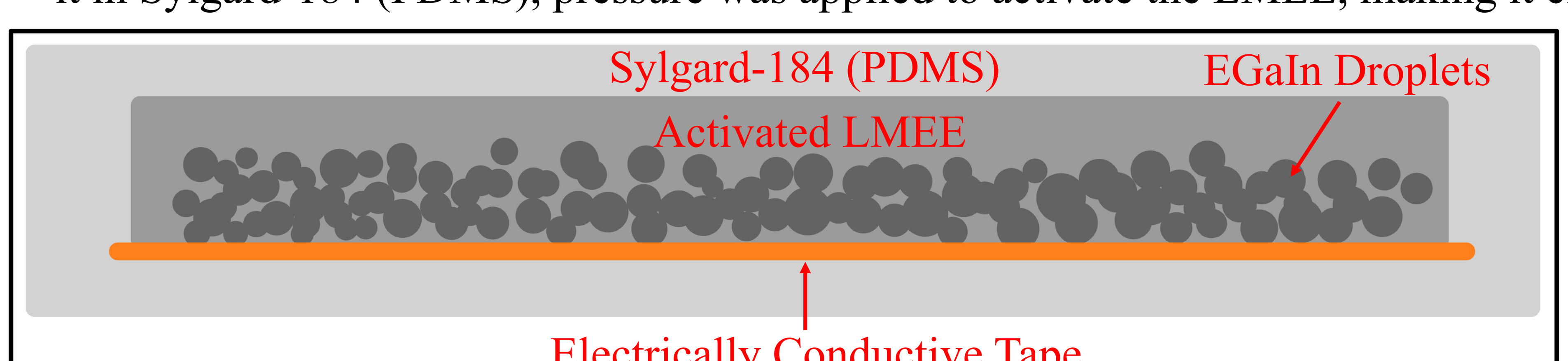
The above circuits were used to measure the open circuit voltage and short circuit current, shown in the graph to the right. An alternating current signal was generated, with positive voltage during compression and negative voltage when there is separation between the electrodes. By multiplying the root mean square values of voltage and current, the power generated by the TENG was calculated to be 430 µW per 2.6 cm^2.



Fabrication of TENG



Liquid metal embedded elastomer (LMEE) was casted onto conductive tape, and wires were soldered to the back of the tape. After encasing it in Sylgard-184 (PDMS), pressure was applied to activate the LMEE, making it electrically conductive. A cross-section is shown below.



To characterize the TENG energy harvesting system, a mechanical testing system (Instron) was used to apply a contact-separation movement between two electrodes and simulate human motion. Here, the copper electrode was secured to the traveling head of a mechanical testing system and the LMEE electrode was fixed to the base. The TENG was cycled at a frequency of 1.03 Hz.

Conclusions/Future Work

- TENGs could be used alongside other forms of energy harvesting, allowing energy to be generated in more environments.
- Simulations could be run to find a more ideal TENG geometry.
- By varying the contact pressure, contact speed, layer thickness, and material composition, the efficiency could be increased.

Acknowledgements

Thank you to Dr. Markvicka and everyone in the Smart Materials and Robotics Laboratory for your input and assistance in completing this project. This work was supported by the Nebraska Public Power District through the Nebraska Center for Energy Sciences Research.

NEBRASKA CENTER FOR ENERGY SCIENCES RESEARCH

Smart Materials and Robotics Laboratory

University of Nebraska Lincoln