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Bendable On-site Thermo Energy Harvester

Flexible, low-cost thermoelectric generators capture waste heat from pipes and bodies to sustainably power IoT sensors without batteries, offering significant cost and mass savings over commercial systems.

Researchers at Purdue University have developed a device to power internet-of-things (IoT) sensors from harvested heat energy. This flexible thermoelectric generator (TEG) is produced via roll-to-roll manufacturing and can be wrapped around cylindrical or semicylindrical bodies (ex. hot water pipelines, the human body) to capture waste heat. These flexible TEGs feature similar power generation to commercial systems while having significant cost and mass savings. As IoT sensors become more common for collecting and communicating real-time data, powering these sensors in a low-maintenance and sustainable manner will become a key design consideration. This technology has applications across any field where waste heat is produced and IoT sensors are being used.

Advantages:

Flexible, lightweight package

Generates power for sensors from waste heat

Significantly lower cost and high productivity compared to commercial alternatives

Can be retrofit onto existing systems or integrated in new systems

Applications:

Capturing energy from pipe heat loss

Body heat energy capture or patch cooling

Technology ID

2020-YAZA-69128

Category

Energy & Power Systems/Power Generation

Materials Science & Nanotechnology/Thermal Management Materials & Solutions

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View online

Enabling IoT connectivity

Technology Validation:

Flexible devices were fabricated, and the resulting power output density of a TEG was 1.26 mW/m2 at a temperature difference of 50 Â°C, which is 2 times higher than the value reported for similar devices. This level of power is capable of supporting IoT sensors without batteries.

Related Publications:

Yining Feng, Kazuaki Yazawa, and Luna Lu. High-Performance Conformal Thermoelectric Generator for Environmental Monitoring. ACS applied electronic materials . Web. doi:10.1021/acsaelm.1c00922.

Kazuaki Yazawa, Yining Feng, and Na Lu. Conformal heat energy harvester on steam pipelines for powering IoT sensors. Energy Conversion and Management. Web. doi:10.1016/j.enconman.2021.114487

Technology Readiness Level: 3

Innovator Biography:

Dr. Kazuaki Yazawa is a Research Professor at Birck Nanotechnology Center at Purdue University. He is a member of the Cooling Technologies Research Center as well. He received his Ph.D. from Toyama Prefectural University in Japan. Dr. Yazawa's research primarily focuses on thermoelectric power generation and thermoelectric refrigeration in applications from the scale of microelectronics to power grids.

Dr. Luna Lu is the Acting Head and Reilly Professor of Civil Engineering, the Director of the Office of Professional Practice, and the Founding Director of Center for Intelligent Infrastructure. Her research on intelligent infrastructure and IoT sensors has received numerous scientific awards, including the 2014 National Science Foundation (NSF) CAREER Award, 2019 Purdue Faculty Scholar, 2021 ASCE Gamechanger Recognition, and 2022 ASCE Alfred Noble Prize etc. She was recently elected to the Fellow of Royal

Society of Arts (FRSA). Luna has founded several start-up companies and translated several technologies from her research lab into engineering applications.

Dr. Yining Feng is a Research Assistant Professor of Civil Engineering, a member of Center for Intelligent Infrastructure at Purdue University. She has extensive knowledge in understanding fundamental transport mechanisms from the nano to micro-scale and apply these to tailor materials' and devices' physical, chemical, thermal, and mechanical properties for specific engineering applications. Her research focuses on sustainability and resiliency of built environment and human-environmental health through developing multi-disciplinary research program in materials and related device technology.

Webpage for Additional Information:

For additional information, visit Dr. Yazawa's Purdue webpage: https://www.purdue.edu/discoverypark/birck/directory/profile.php?resource_id=147993 or the Cooling Technologies Research Center website:

https://engineering.purdue.edu/CTRC/welcome.php

Purdue Joe and Lisa Shetterley Innovation Lab
https://engineering.purdue.edu/SMARTLab

TRL: 3

Intellectual Property:

Provisional-Gov. Funding, 2021-07-30, United States | Utility-Gov. Funding, 2022-07-27, United States

Keywords: flexible thermoelectric generator, TEG, IoT sensor power, waste heat harvesting, energy harvesting, roll-to-roll manufacturing, conformal TEG, battery-free sensors, heat energy capture, sustainable power, Additive Manufacturing, Energy, Heat Transfer, Internet of Things, IoT, Power, Roll-to-Roll, Sensors, Thermal, Thermoelectric, Waste Heat