**Wearable textile based energy harvester designed for human motion**

Rebeca M. Gurrola\(^1\)\(^2\)\(^3\), Janna Eaves\(^1\), Cary Pint\(^1\)\(^2\)

\(^1\)Vanderbilt University, Department of Mechanical Engineering, Nashville TN, 37235, \(^2\)Vanderbilt University, Department of Interdisciplinary Materials Science, Nashville TN, 37235, \(^3\)St. Mary’s University, Department of Physics and Mathematics, San Antonio TX, 78228

## Introduction

### Need for harvesters?
- Recent advances in cybernetics, artificial intelligence, and personal technology call for more energy in small or unusual form factors.
- To power these advancements, the energy of human motion.
- Takes place from 50-100 Hz.
- Na and Sn are cheaper than Li.

### Energy Harvesters:
- These harvesters convert mechanical strain at low frequencies into electrical energy.
- Bending creates strain in lattice of active material and induces potential gradient.
- Sensitivity to strain and changes in electrolyte inspire exploration of sensing applications.

### Why Tin-Sodium System?
- Na is 1000 times more abundant than Li in the earth’s crust. Both Na and Sn are cheaper than Li.
- Sn is non-toxic and compatible with aqueous electrolyte.
- High theoretical sodium storage capacity of 847 mAh/g.\(^1\)
- Alloys of larger ions have a higher OCV.\(^4\)

## Sodiation of Plated Textile

### Step 1: Transform textile into energy harvester

**Figure 3.** (a) Tin was electrochemically alloyed with sodium at constant current of 15 µA over 8.5 hours for a total sodium concentration of 10.11 mg/cm\(^2\). (b) Two-electrode electrochemical cell used for sodiation.

### Step 2: Assemble harvester and test performance.

**Figure 4.** (a) Short circuit current (SCC) response and (b) open circuit voltage (OCV) of harvester in 1M and 0.1M NaCl solutions. (c) Subset of SCC plot for 1M electrolyte showing nature of response in bent and unbent states. (d) Photograph of assembled device. (e) Schematic representation of the operation of an electrochemical energy harvester. (f) Photograph showing bend tests on energy harvester.

### High Performance, Smart Harvesting

**Figure 5.** Performance of the Sodium-Tin energy harvester described in this work.

**Figure 6.** Plot of measured performance from energy harvesting textiles versus state-of-the-art in the literature. Our devices show highest performance measured to date.

## Future Work

- Further analysis of hydration monitoring capability and additional sensing opportunities.
- Identify optimal packaging method.
- Human motion testing.
- Further testing using different weaves of fabric.

## References


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