Are piezoelectrics good for generating electricity? Perhaps, but we must decide how to evaluate them

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An artistic impression of electricity generation in a piezoelectric energy harvester made from piezoelectric nanofibers. Credit: Katharina Maisenbacher, Max Planck Institute for Polymer Research

A 'best practice' protocol for researchers developing piezoelectric materials has been developed by scientists—a first in this cutting-edge field of technology.

The protocol was developed by an international team led by physicists at University of Bath in the UK, in response to findings that experimental reports lack consistency. The researchers made the shocking discovery that 9 out of 10 scientific papers miss experimental information that is crucial to ensure the reproducibility of the reported work. They discuss the urgent need for a standardized piezoelectricity research protocol in the journal *Nano Energy*.

Dr. Morteza Hassanpour Amiri at the Max Planck Institute for Polymer Research, Germany and first author of the study, said, "Research into piezoelectricity has accelerated in recent years, and for good reason: piezoelectric materials generate electricity when you exert pressure or mechanical vibrations, or when you tap on or distort them. Add a circuit and this electricity can be stored and then used."

High energy-harvesting efficiency

Because of the huge potential of the piezoelectrics, over the past 20 years a steady stream of new materials and composites have been developed and tested for their energy harvesting potential, with many claiming high efficiencies.

But the researchers, led by Professor Kamal Asadi from the Department of Physics, suggest these findings—sometimes published in high-caliber journals—often do not include details of key experimental parameters. These details are essential to ensure reproducibility when other research teams set out to independently evaluate or further improve the featured materials.

Explaining, Professor Asadi said, "Reproducibility of experimental research findings may not be the key to the success of a research, but it is the key to ruling out unreliable findings from being accepted as fact. The enthusiasm to develop a champion material that shows impressive performance should be accompanied with enough supporting data."

For the study, the Bath researchers assessed 80 randomly selected research papers published over the past two decades on piezoelectric energy harvesting devices. For nearly 90% of these papers, essential experimental parameters—needed to evaluate materials and devices—were missing, thus rendering the experiments hard, and sometimes impossible, to reproduce.

The importance of reproducibility

Expanding, Professor Asadi said, "There are three important reasons why reproducibility is important: We are scientists and should strive to be as accurate as possible; we have limited resources, so by reporting all the necessary parameters that guarantee reproducibility, we are helping our peers to build up on our findings and advance the field; by being transparent, we also build trust with the public, and with science funding organizations and policymakers, and provide a better guidance for future 'big' decisions that can affect us all."

Professor Asadi, who is a leading expert in piezoelectricity, says this lack of data is hampering progress in the field, as researchers can't turn to the literature to identify materials with the best harvesting potential, and then further develop these promising materials.

New protocol

The new Bath protocol suggests a standardized data collection and

reporting. Professor Chris Bowen from the Department of Mechanical Engineering at Bath, who was also involved in this study, said, "We have basically created guidelines that would be helpful to researchers in their field of piezoelectricity."

Professor Asadi is hopeful that electronic devices powered by piezoelectricity will be on the market within the next 10 years.

"That's why it's important to have a standardized protocol for reporting research data for a quantitative evaluation of energy harvesting materials and devices. Doing so enables scientists to make real progress building on each other's experiments and working towards a common goal: making piezoelectricity a reality for anyone hoping to charge their devices more sustainably and without reliance on a traditional power source."

He added, "The field of piezoelectric energy harvesting is a really exciting field, it has lots of potential and great scientists are working on it, but it's still fledgling, and so to make sure we advance as well and as quickly as possible, ensuring experiments are reproducible is going to be crucial, so I hope our suggested protocol is adopted by the community at large."

More information: Morteza Hassanpour Amiri et al, Piezoelectric energy harvesters: A critical assessment and a standardized reporting of power-producing vibrational harvesters, *Nano Energy* (2022). DOI: 10.1016/j.nanoen.2022.108073

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