Researchers discover source for generating 'green' electricity

June 22 2011

University of Minnesota engineering researchers in the College of Science and Engineering have recently discovered a new alloy material that converts heat directly into electricity. This revolutionary energy conversion method is in the early stages of development, but it could have wide-sweeping impact on creating environmentally friendly electricity from waste heat sources.

Researchers say the material could potentially be used to capture waste heat from a car's exhaust that would heat the material and produce electricity for charging the battery in a hybrid car. Other possible future uses include capturing rejected heat from industrial and power plants or temperature differences in the ocean to create electricity. The research team is looking into possible commercialization of the technology.

"This research is very promising because it presents an entirely new method for energy conversion that's never been done before," said University of Minnesota aerospace engineering and mechanics professor Richard James, who led the research team."It's also the ultimate 'green' way to create electricity because it uses waste heat to create electricity with no carbon dioxide."

To create the material, the research team combined elements at the atomic level to create a new multiferroic alloy, $Ni_{45}Co_5Mn_{40}Sn_{10}$. Multiferroic materials combine unusual elastic, magnetic and electric properties. The alloy $Ni_{45}Co_5Mn_{40}Sn_{10}$ achieves multiferroism by undergoing a highly reversible phase transformation where one solid

turns into another solid. During this phase transformation the alloy undergoes changes in its magnetic properties that are exploited in the energy conversion device.

During a small-scale demonstration in a University of Minnesota lab, the new material created by the researchers begins as a non-magnetic material, then suddenly becomes strongly magnetic when the temperature is raised a small amount. When this happens, the material absorbs heat and spontaneously produces electricity in a surrounding coil. Some of this heat energy is lost in a process called hysteresis. A critical discovery of the team is a systematic way to minimize hysteresis in phase transformations. The team's research was recently published in the first issue of the new scientific journal *Advanced Energy Materials.*

In addition to Professor James, other members of the research team include University of Minnesota aerospace engineering and mechanics post-doctoral researchers Vijay Srivastava and Kanwal Bhatti, and Ph.D. student Yintao Song. The team is also working with University of Minnesota chemical engineering and materials science professor Christopher Leighton to create a thin film of the material that could be used, for example, to convert some of the waste heat from computers into electricity.

"This research crosses all boundaries of science and engineering," James said. "It includes engineering, physics, materials, chemistry, mathematics and more. It has required all of us within the university's College of Science and Engineering to work together to think in new ways."

Provided by University of Minnesota