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Thermoelectric energy conversion: Recent Progress and Applications

Joseph P. Heremans

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Lecture at 4:15 PM

Light refreshments follow

Room 66-110

25 Ames Street

Abstract

The most obvious way to address the pending energy crisis is to conserve energy. Overall, the efficiency of the production and distribution of static electrical power is much higher than that of transportation devices. Consequently, it is in automotive applications that the best short-term opportunities exist to recover a fraction of that waste heat through thermodynamic "bottoming cycles", i.e. technologies that use convert the heat lost by the engine in its exhaust to useful work. If we could recover 10% of the heat lost in transportation devices, we would save as much energy as the hydroelectric or biomass industries produce.

Thermoelectric (TE) energy converters are all-solid-state heat engines that convert heat into electrical power. They can be inverted and used as heat pumps (Peltier coolers). Their advantages are their extreme reliability and power density, related to the absence of moving parts. While in the long run TE converters could become to conventional heat engines what the transistor is to the vacuum tube, the efficiency of existing TE materials has remained low, limiting their use to niche applications. Research in this last decade has doubled the efficiency of TE materials, through the use of nanostructuring and of a band structure engineering technique whereby we distort the electronic density of states. This talk will give an overview of the new TE materials and of the new classes of applications they open.

About the Speaker

Joseph P. Heremans is an Ohio Eminent Scholar and professor of Mechanical Engineering and Physics at the Ohio State University. He holds a Ph. D. in Applied Physics from the Catholic University of Louvain (1978); after appointments as a visiting scientist (MIT, U. Tokyo), he joined the research staff at the General Motors Research Laboratories, where he became the leader of the Electro-optical Physics group and later the manager of the Semiconductor Physics section. He joined the Delphi Research Laboratories as a fellow in 1999, and the Ohio State University in 2005. In 2006, he was elected chair of the Forum for Industrial and Applied Physics, the largest unit of the American Physical Society. His research is focused on the electrical and thermal transport properties of narrow-gap semiconductors (PbTe, InSb) and semimetals (bismuth, graphites). While most of his work is published, including in the journal Science, three groups of his 37 issued US patents have resulted in commercial products. His latest field of interest is in the development of high-efficiency thermoelectric materials.

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