Nonequilibrium Thermoelectrics: Low-Cost, High-Performance Materials for Cooling and Power Generation

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for Cooling and Power Generation

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Technology Description
Thermoelectric materials can be made into coolers (TECs) that use electricity to develop a temperature difference, cooling something, or generators (TEGs) that convert heat directly to electricity. One application of TEGs is to place them in a waste heat stream to recuperate some of the power being lost and putting it to use more profitably.

To be effective thermoelectrics, however, materials must have both high electrical conductivity and low thermal conductivity, a combination rarely found in nature. Materials selection and processing has led to the development of several systems with a figure of merit, ZT, of nearly unity. By using non-equilibrium techniques, we have fabricated higher efficiency thermoelectric materials. The process involves creating an amorphous material through melt-spinning and then sintering it with either spark plasma or a hot press for as little as two minutes. This results in a 100% dense material with an extremely fine grain structure. The grain boundaries appear to retard phonons resulting in a reduced thermal conductivity while the electrons move through the material relatively unchecked.

The techniques used are low-cost and scaleable to support industrial manufacturing.

Markets and Applications
Automobile and aircraft manufacturers and their suppliers will use this technology in systems designed to capture waste heat and use it to power electronics.

The technology can also be used to harvest waste heat from industrial operations and transform it into useful electricity.

Commercial Readiness
With initial capital equipment purchases of $2-3 million, a team of five could achieve scale-up within one to two years.

Intellectual Property
U.S. Patent Application Ser. No. 12/945,677 was filed Nov. 12, 2010. It claims the structures and methods of making them. During scale-up to commercial production it is likely that patentable methods will be developed relating to materials processing. An industrial partner may also choose to protect certain know-how gained during scale-up as trade secrets.

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