Energy Technology | Technology Offer (incl. Attachment)

First printable thermoelectric generator (TEG): powerful, compact, flexible, scalable

Current Technology and its Drawbacks

Thermoelectric systems can be divided into two categories:

Thermoelectric generators (TEGs) which generate an electric current from a temperature difference based on the Seebeck effect, and thermoelectric heat pumps which generate cooling or heating while consuming electricity.

To date, such systems are made of inorganic materials such as bismuth telluride, which contain expensive and poisonous heavy metals. Because of the hardness and brittleness of these materials, complex manufacturing processes are necessary. Furthermore, pre-structured, mechanically stable ceramics are required as support materials.

TEGs made of organic materials offer significant advantages in this respect because by using printing processes large surface area can be manufactured quickly, simply and inexpensively and without having to use problematic compounds. Up to now, layers of a thickness of only a few micrometers could be produced by using conventional printing processes. The thickness of such layers is not sufficient to generate significant electric power.

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Innovation / Advantages

Researchers of the Karlsruhe Institute of Technology (KIT) succeeded in developing a novel and costeffective thermoelectric system which achieves the combination of the advantages of processing thin organic layers with the benefits of thick generators with high power.

Through simple process variations it is possible cost-effectively to produce TEGs of any size which allow the fabrication of TEGs with the required output voltage, internal resistance and thermal resistance that are optimal for any given application.

The fact that unstructured, flexible films are used as support materials significantly simplifies and accelerates the process.

Your Competitive Advantages at a Glance

- Simplified cost-effective production of TEGs (volume production using printing process)
- Reduction in processing steps (no pre-structuring or contacting required)
- Increased efficiency through customized dimensioning
- TEG with high rigidity (no ceramics for mechanical stabilization required)
- Measures to prevent short-circuiting are not required due to the selected construction
- Improved performance through avoidance of cavities
- New applications through flexible devices

Patent Situation

Patent application filed in Germany; international patent application planned.

Advantages and Applications of the Organic TEG

The Applications at a Glance

- Energy supply for autonomous electronic sensors and circuits using waste heat
- Obtaining electrical energy form process waste heat (e.g. power plants, geothermal)
- Electric cooling device by removing heat (e.g. refrigerator)
- Electric heater by supplying thermal energy
- Electricity supply for electronic devices incorporated in textiles ("wearable electronics") or for portable electronic devices (e.g. mobile phone chargers) by making use of body heat.

Advantage: Energy supply for autonomous sensors and electronic circuits

For the monitoring and control of industrial processes, numerous sensors are often required. While these devices can transmit their readings wirelessly to a central receiver, they still generally require the supply of electric power either through wires or from batteries. To provide such power involves substantial installations respectively maintenance costs. Alternatively, TEGs could provide the necessary electric energy by utilizing waste heat that may be available in the vicinity of the sensor, thus contributing to reduced cost and greater flexibility. Implementation of this concept has failed until now because of the high costs of production of conventional TEGs. The new organic TEG is inexpensive by mass production and thus provides a crucial competitive advantage for this application.

Advantage: Production of energy from waste heat in power plants and geothermal plants

All power plants that produce electricity from heat also produce waste heat, generally at a relatively low temperature. Likewise industrial processes as well as geothermal plants often produce large quantities of waste heat at low temperatures. The low temperatures involved make the use of classical heat engines uneconomical. TEGs on the other hand can transform even small temperature differences efficiently into electrical energy. The large-scale use of conventional TEGs failed to meet this market so far, due to the high production costs. The new organic TEG which is produced cost-effectively and in large sizes by a printing process opens up a promising market opportunity.

Advantage: Use as a heat pump

By applying an electric current to a TEG, it can operate as a heat pump. Using flexible organic materials makes it possible to adjust the geometry of the TEG, respectively the heat pump to curved shapes and even to flexible surfaces. This makes it possible for example to integrate temperature regulation devices into car seats that will heat and cool by using a minimum of energy. Another economic application could be temperature control of the battery pack in electric cars, thus increasing the power and useful life of the pack.

Advantage: Operation of portable electronic functional units

The mechanical flexibility of organic TEGs allows their direct integration into textiles that are worn on the body. In this way, small amounts of electric power can be generated, which can be used, for example, to operate mobile phones or other electronic devices.

Collaborative Partners / Licensees wanted!

The invention is currently at the „proof of concept“ stage. We are interested in pushing on the development of these organic TEGs to market readiness together with an industrial partner.