

Thermoelectric Materials and Systems

Thermoelectric generators are widely known as very robust and reliable electrical power supplies for deep space probes and planetary landers. The department "Thermoelectric Materials and Systems" develops materials and technologies for thermal-to-electric energy conversion aimed at a wide temperature range. Terrestrial applications encompass energy recovery in the automobile by means of exhaust heat-to-electricity conversion, autarkic residential heat supplies and low-power current sources. The spectrum of methods in the department includes materials synthesis, contacting and integration techniques, materials and system characterization as well as numerical simulation and model-based system design.

Novel thermoelectric materials

The target entity of thermoelectric materials development is the thermoelectric figure-of-merit. Novel materials, in particular, nanostructured ones, based on chalcogenides, skutterudites, silicides or clathrates are potential candidates for reaching higher efficiencies and thus pave the way for attracting broader interest in this technology, well beyond niche and specialist applications, it has been restricted to so far.

Thermoelectric energy conversion

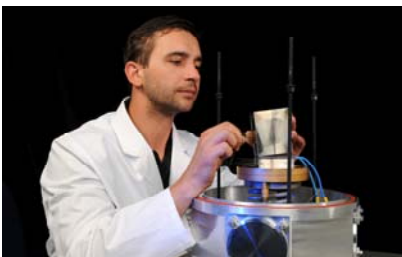
Thermoelectric energy converters (TE generators) are gaining more and more importance as they do not involve any mechanically moving parts and thus guarantee high reliability along with noiseless and maintenance-free operation. Moreover, they can be operated over a wide temperature range. The enormous amount of heat being lost from power plants, factories, transports, and residential homes offers a great opportunity for making direct use of this energy. In many energy systems – such as automotive –

direct conversion of heat flows into electrical power allows for a reduction of fuel consumption and thus for a sustainable protection of the environment.

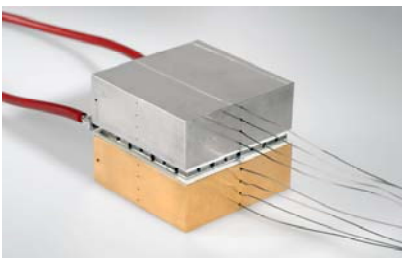
When exposed to intermediate or high temperatures beyond ca. 400°C, novel TE generators can achieve efficiency factors of ten percent over even more. Here, the key for innovations lies in the development of thermoelectric materials which – besides high efficiency – show long-term stability as well as robustness and high integrity of the electrical interconnects. The department "Thermoelectric Materials and Systems" is backing this process with its experience and expertise gathered over the last fifteen years of continuous research in the field. Particularly, it has been recognized for groundbreaking work in the areas of automated functional characterization and the numerical design of thermoelectric materials, modules, and segmented TE generators.

Thermoelectric measurement technology

Efficient experimental set-ups for temperature-dependent characterization of thermoelectric materials and system properties are complex facilities and are commercially not sufficiently available, in particular for higher sample temperatures. The department "Thermoelectric Materials and Systems" has designed, automated, and tested a family of computer-controlled modular measurement systems capable of recording the Seebeck coefficient, the electrical as well as the thermal conductivity, and the thermoelectric figure-of-merit in a wide temperature range. Moreover, the spatial inhomogeneity of thermoelectric properties can be visualized. Facilities for system characterization enable evaluation of the efficiency of TE generators under real and variable thermal as well as mechanical operation conditions.



Test-rig for thermoelectric modules.



Reference assembly for module characterization.

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