Fraunhofer IPM

Measuring laboratory thermoelectrics

Precise characterization of thermoelectric modules

We develop measuring devices for thermoelectrics designed to determine the entire range of essential characteristics of thermoelectric modules.

The quality of thermoelectric modules and their thermal coupling determine how efficiently they make use of waste heat. Fraunhofer IPM provides various measuring devices that are especially designed to precisely characterize thermoelectric modules of different designs and sizes in terms of their thermoelectric properties, performance, processing and long-term stability.

Module measuring device

The module measuring device was especially designed for characterizing thermoelectric modules (TE modules). At the measuring device, TE modules of different sizes and designs can be characterized with regard to their thermoelectric performance and their temperature-dependent internal resistance. In addition, the optimum operating conditions in terms of temperatures and contact pressures can be determined.

The current and voltage generated by the TE module are measured as a function of the temperature on the hot and cold side, as well as of the heat flux through the module. For this purpose, the modules together with a heat flow meter are clamped between a ceramic heater and a heat exchanger and pressed on with a predefined pressure. It is also possible to monitor the temperature distribution of the outermost pairs of legs on the Z-axis using an infrared camera. Different atmospheres – from vacuum to overpressure with different gases – can be created in the measurement chamber to simulate different application scenarios.

Parameter variations

- Cold side: 5 – 80 °C
- Hot side: up to 650 °C
- Contact pressure: depending on module size from 0 to 12 MPa
- Module dimensions: 16 × 16 mm² to 50 × 50 mm² and round modules

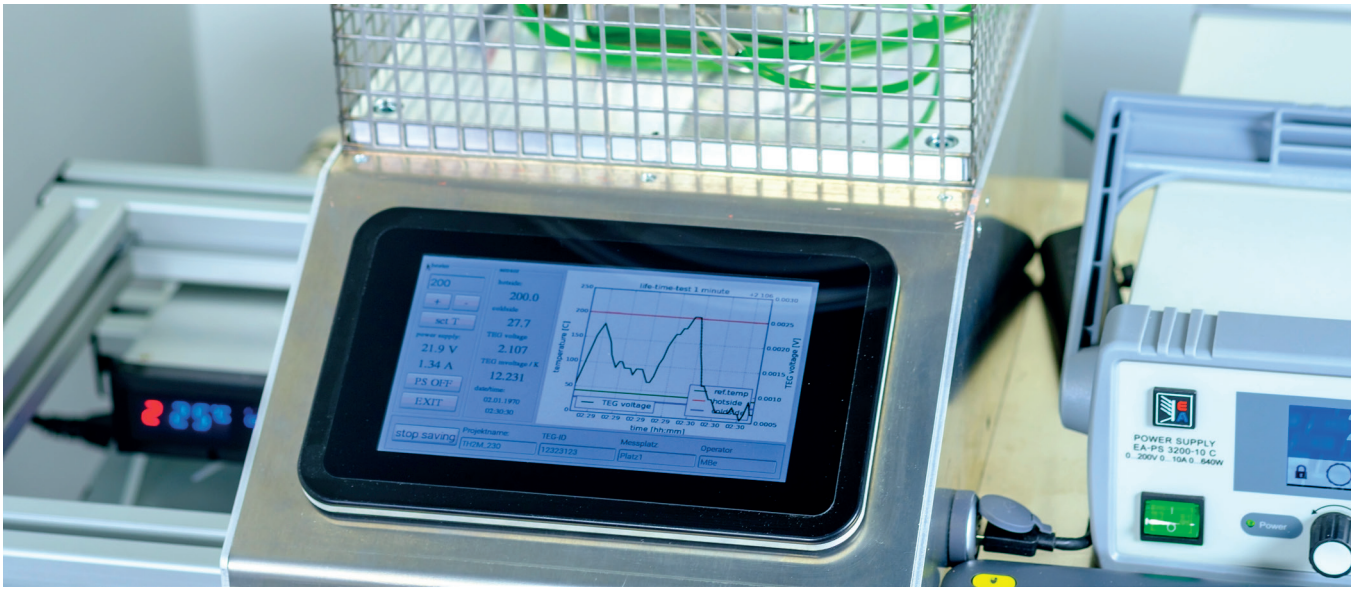
Harman measuring device

The measuring device developed by Fraunhofer IPM enables precise measurements according to the Harman principle for determining the figure of merit ZT at room temperature.

Overview

We develop custom-made measuring technology for TE modules, and we measure on behalf of our customers.

- **Module measuring device**
  Performance, internal resistance, operating conditions
- **Cycle measuring device**
  Long-term tests
- **DT-Air measuring device**
  Long-term degradation measurements under air
- **Harman measuring device**
  Figure of merit ZT



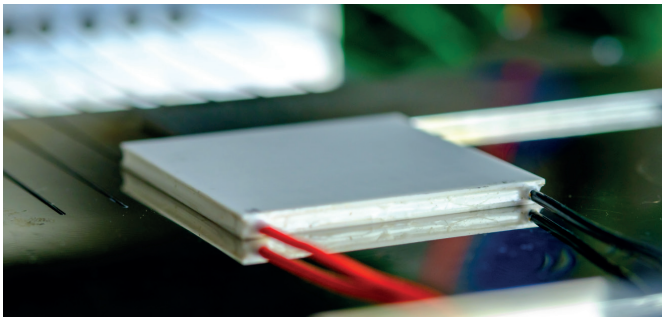
How do materials and joining technology behave over long periods of time? Long-term measurements can be carried out at the DT-Air measuring device.

Cycle measuring device

At the cycle measuring device, TE modules are characterized in terms of their thermoelectric properties under thermal stress in long-term tests. The contact pressure can be changed during the measurement in order to perform close-to-application examinations of the modules.

Parameter variations

- Cold side: 5–80 °C
- Hot side: up to 500 °C
- Contact pressure: up to 30 MPa
- Module dimensions: from 16 × 16 mm² to 80 × 80 mm² and round modules



How many cycles can a TE module withstand at different temperatures and pressures? This can be tested in long-term endurance tests at the cycle measuring device.

DT-Air measuring device

Modules often fail due to degradation of solder joints and materials which are caused by exposition to air. The DT-Air measuring device was designed for long-term measurements of thermoelectric modules when exposed to air. Degradation is characterized by measuring the voltage generated by the module at no-load or via a power resistor.

Parameter variations

- Cold side: 5–80 °C
- Hot side: up to 600 °C
- Module dimensions: from 16 × 16 mm² to 50 × 50 mm²
- Measurement runs up to a few weeks

Contact

Dr. Olaf Schäfer-Welsen
Head of Department Thermal Energy Converters
Phone +49 761 8857-173
olaf.schaefer-welsen@ipm.fraunhofer.de

M. Sc. Roland Binninger
Project Manager
Phone +49 761 8857-144
roland.binninger@ipm.fraunhofer.de

Fraunhofer Institute for Physical Measurement Techniques IPM
Georges-Köhler-Allee 301
79110 Freiburg, Germany
www.ipm.fraunhofer.de/en