

# Thermal management for electronics

## Heat dissipation and temperature control

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### Heatpipes, caloric systems and Peltier coolers

As the power and packing density of electronic components increase, the amount of waste heat generated in a small space also rises greatly. This results in dangerously high temperatures and thus increases the failure risk of electronic devices. Fraunhofer IPM develops thermal management solutions based on caloric systems, Peltier coolers and heat pipes.

#### More power – more waste heat

Today, 55 percent of electronic component failures are caused by increased temperatures alone. The electronic characteristics of batteries are dependent on operating temperature; battery cells age quickly if operated at excessively high temperatures. These examples clearly demonstrate that tailor-made cooling concepts are becoming more and more important in order to avoid thermal overload. Furthermore, many systems today can be operated in a defined temperature range only.

#### Individual heat dissipation and temperature control concepts

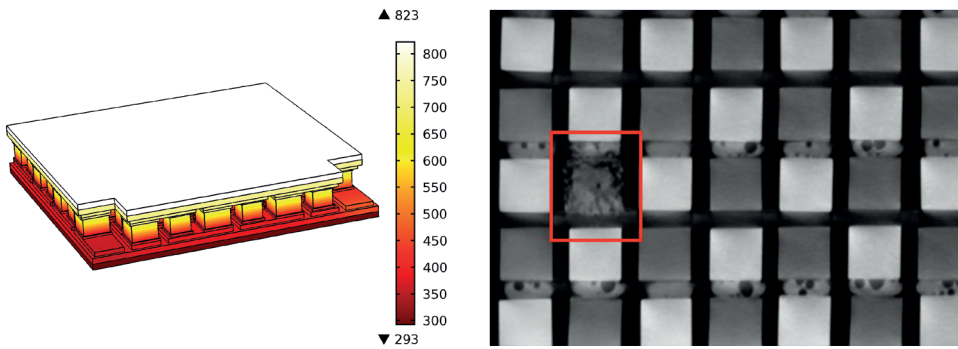
Fraunhofer IPM offers services for thermal management – e.g. for heat dissipation from electronic components on (printed) circuit boards or for battery cooling. The focus is on heat dissipation and temperature control solutions for small to moderate thermal loads. These are based on caloric systems, Peltier coolers and heat pipes which we develop in line with our customers' individual specifications.

*Thermal management is increasing in importance in view of more and more powerful electronics.*

#### Our services

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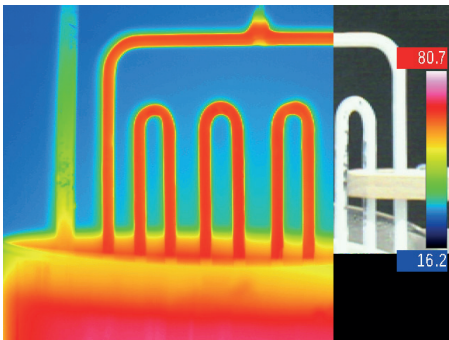
- Solutions for thermal management – e.g. of components on circuit boards, batteries, etc.
- Thermal system design
- Assembly, development, characterization and coupling of heat pipes, caloric cooling systems, Peltier coolers, heat exchangers, etc.
- Design, construction, simulation and characterization of different types of heatpipes
- Processing and shaping of materials
- Prototype construction with state-of-the-art CAD/CAM systems



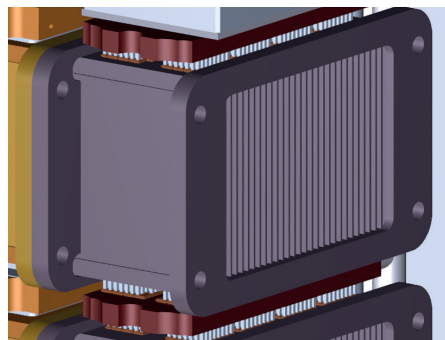
FEM simulation of the temperature distribution in a Peltier module with a fixed hot and cold side temperature of 600 and 30 °C. The underlying simulation also considers the thermoelectric effects.

### Broad range of measurement methods and thermal simulation

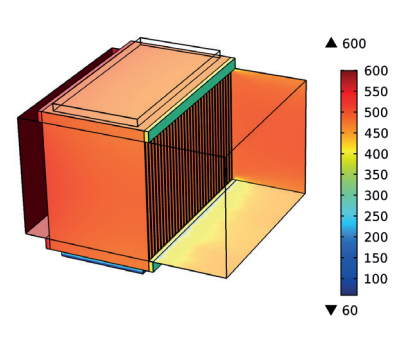
- Measurement of temperatures and heat flow etc. – e.g. using thermal imaging cameras or heat flow meters
- Thermal simulations of temperatures and heat flow, stationary and dynamic, with various boundary conditions – using COMSOL Multiphysics software packages
- Material characterization of thermal conductivities and heat capacities, coefficients of expansion and specific densities (differential calorimetry, laser flash analysis, time-domain thermoreflectance, dilatometry, etc.)
- Structural characterization and failure analysis (also as a prerequisite for FMEA analyses) of materials – e.g. using scanning electron microscopy, 3D computer tomography and X-ray structural analysis
- Thermal characterization of components and systems – e.g. using IR thermography, heat flow meters, etc.



Left: Thermographic image of a pulsating heatpipe (PHP) immersed in a hot liquid. A PHP exhibits an enormously high effective thermal conductivity. Compared to a solid copper rod (left in the picture) the temperature compensation with a hot liquid takes place very fast in the whole volume.



Center: CAD model of a system consisting of heat exchanger (dark gray) and Peltier modules (brown and light gray).



Right: FEM simulation of the temperature distribution in the heat exchanger (Fig. 5). Gas at a temperature of 600 °C flows through the heat exchanger, which is connected to Peltier modules with a cold side temperature of 70 °C.

### Contact

Dr. Markus Winkler  
 Project Manager  
 Phone +49 761 8857-611  
 markus.winkler@ipm.fraunhofer.de

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

