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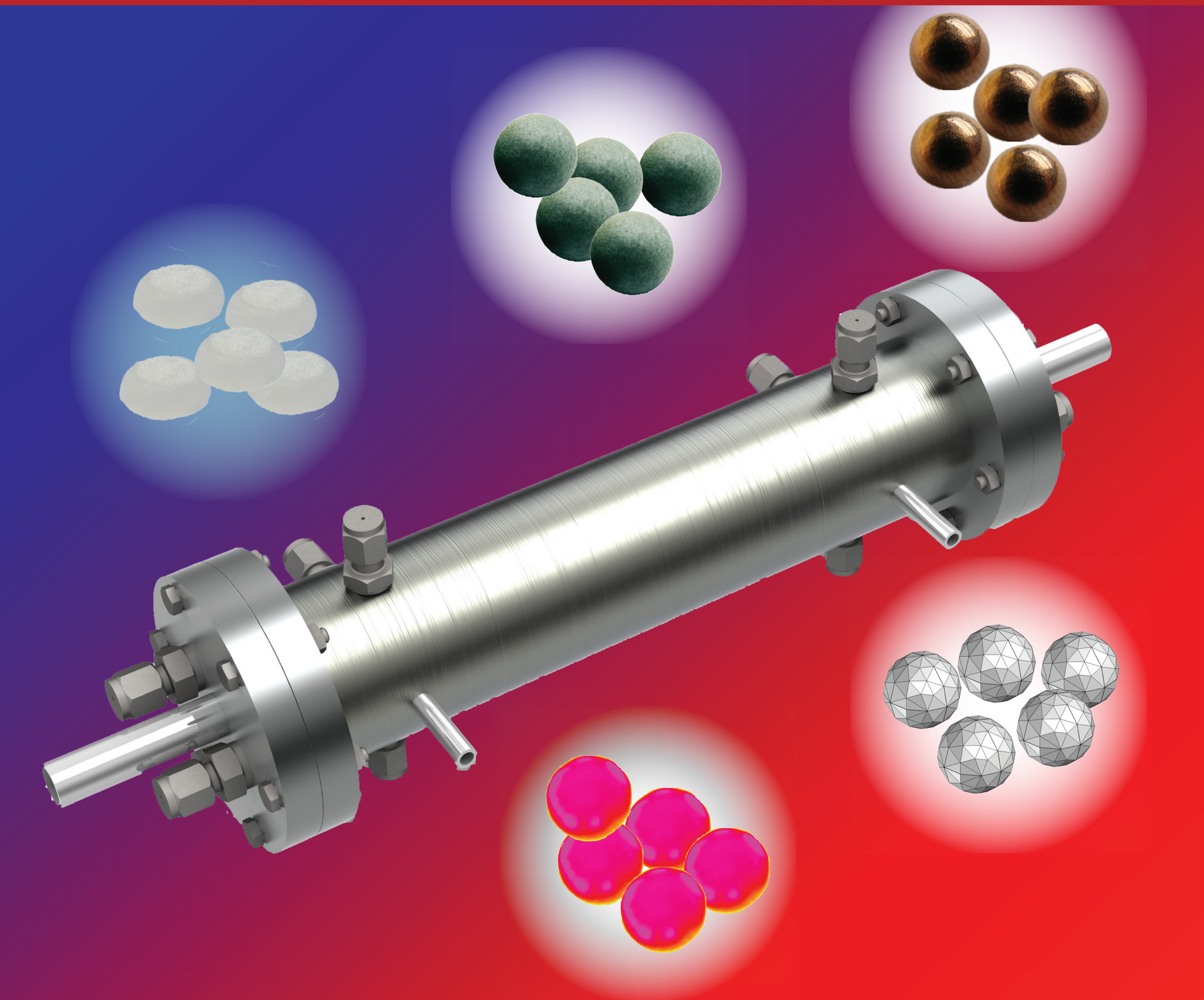
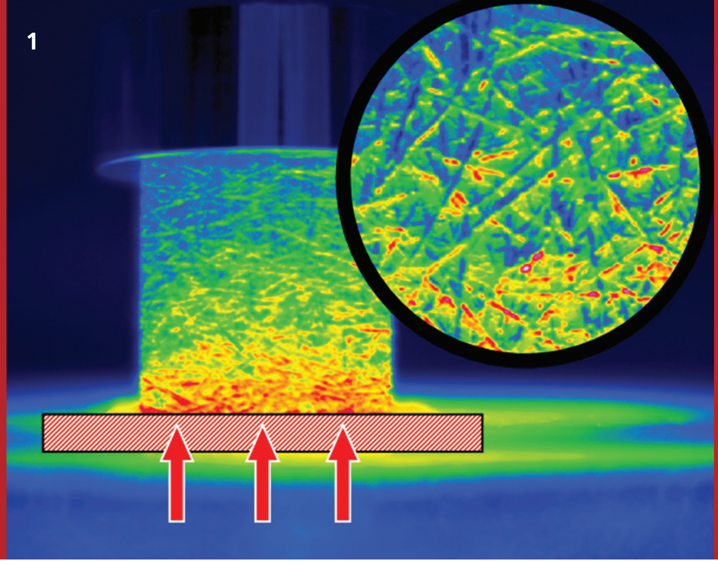
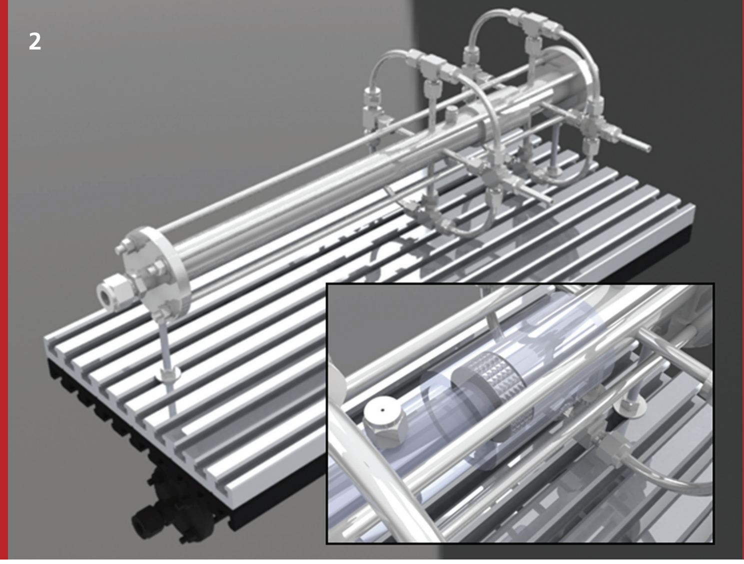
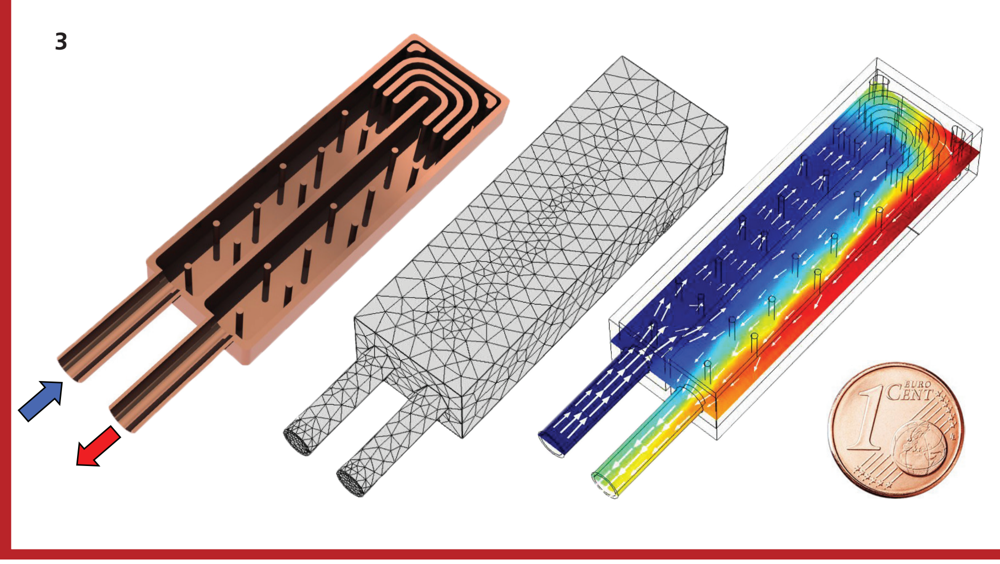
ENERGY AND THERMAL MANAGEMENT









COMPETENCIES

The main concern of the business unit Energy and Thermal Management is the technological transfer among the scientific fields of materials science and power engineering in the following areas

- efficient storage of thermal energy (heat – cold),
- optimisation of heat transfer processes (heating – cooling – evaporation – condensation),
- solution of demanding tasks related to thermal management.

Furthermore, any thermodynamic and fluidic problems are handled, even without a reference to the developed materials, for instance

- thermo-technical design of components in power and process engineering.

The associates of the business unit exhibit a diversified technical knowledge and know-how concerning experimental studies and mathematical modelling of complex heat, momentum and mass transfer processes, deriving from a long-time work experience.

SERVICES

First and foremost, the business unit provides competent support in regard to the development of systems in power and process engineering for variable applications in multiple magnitude scales.

In particular, the offer addresses business partners or associate research groups who are interested in material-scientific and thermodynamic know-how from one source.

Examples for versatile complexes dealt with in the business unit are:

- thermo-technical and fluidic design of single components or entire technical systems such as
  - efficient heat exchangers,
  - high-performance thermal storage devices,
  - evaporators / condensers,
  - high-power temperature regulating systems,
  - micro-cooling systems and many more,
- the definition of demands for optimised material systems and the interaction with accordant specialists,
- the characterisation and mathematical description of thermal and fluidic material properties,
- the experimental validation of single assemblies or prototypical systems.

Core skills in the fields of thermal storage or heat transport and thermal management enclose

- computation of steady-state or transient temperature fields in (an-)isotropic systems,
- modelling of mass, momentum and heat transfer under variable boundary conditions (including phase change phenomena),
- measurement and/or computation of thermal properties and transport coefficients of materials and composites (heat conductivity, heat capacity, thermal elongation),
- experimental determination of thermal and fluidic parameters such as heat transfer or pressure loss coefficients.

METHODS

The solution of a problem concerning a fluidic or thermal matter can be achieved in completely different manners. This especially depends on the available material and temporal resources plus the required accuracy and ability to extrapolate the results.

Mathematical methods offer the advantage of a flexible design of components as well as the comfortable simulation of different operating states. Mostly, reliable results can only be obtained in combination with experimental studies – e.g. for the determination of properties and transport coefficients or tests of prototypical systems.

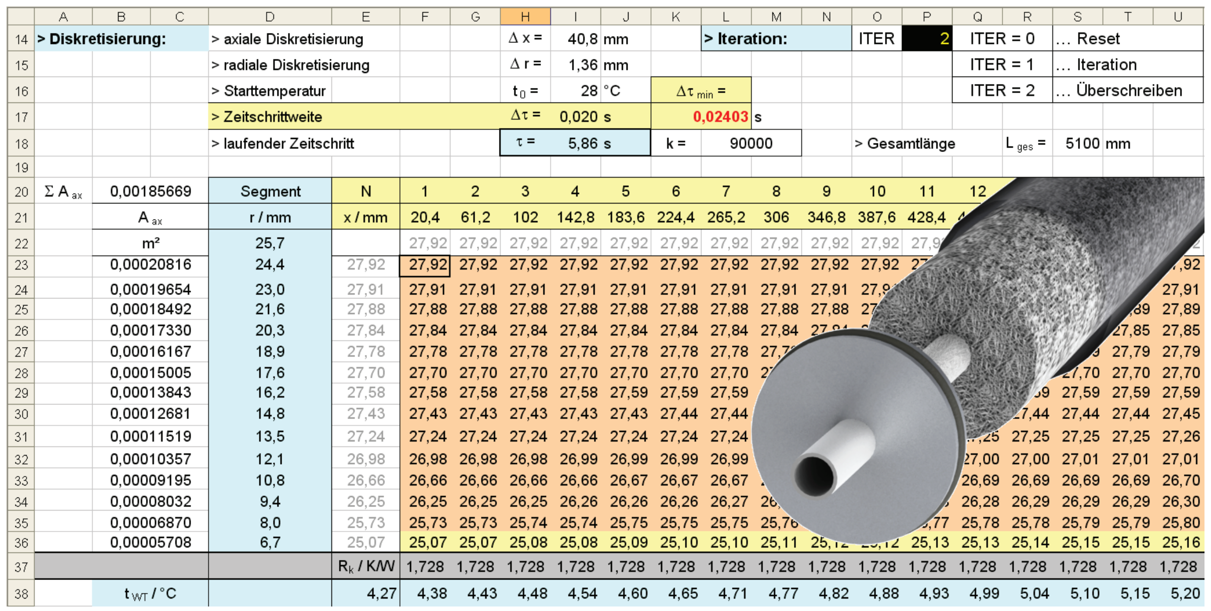
We would be glad to offer you a customised solution!

Mathematical modelling

Empirical correlations are suitable to describe well-known single phenomena (heat transfer in pipes) and to design entire assemblies (rod-bundle heat exchangers).

Balance equations for momentum, heat and mass transfer can be solved in a simplified way by means of own algorithms (e.g. MS Excel®, Visual Basic®, Delphi®). Thereby, the flexibility of the programming and the high potential to adapt those to different thermal boundary conditions are utile.

The software tool COMSOL Multiphysics® can be applied for numerical simulations of complex systems, allowing a simulation of merging physical phenomena along with many user specific options.



Transient calculation scheme for a prototypical latent-heat storage device

1 *Thermographic picture of an aluminium fiber structure heated at the bottom side,*
2 *Model of a measuring channel to characterize the flow conditions in open-celled materials*

3 *Prototypical micro-cooling units applicable for LEDs alongside a CFD-computation model,*
4 *Measurement setup (hot disk system) for the determination of the thermal conductivity of a hollow sphere structure*

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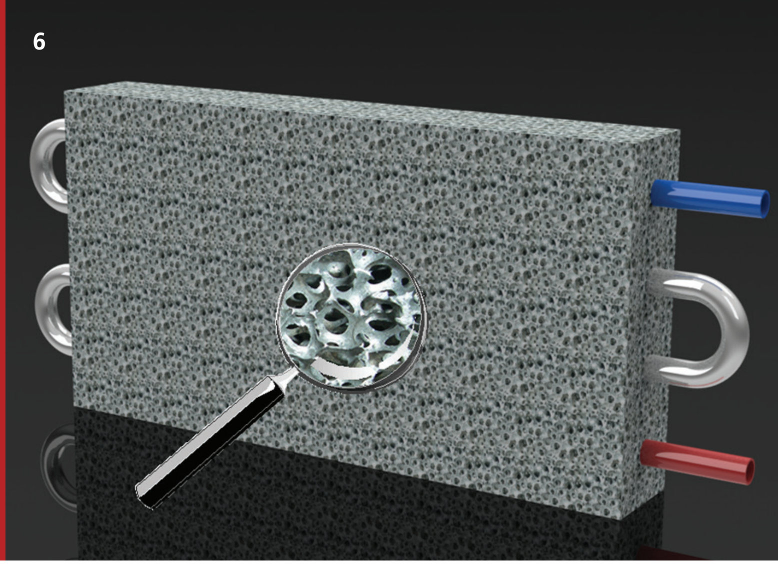

Experimental Studies

A basic requirement of each computation is a reliable knowledge of properties and transport coefficients, which depend on many influencing factors and, therefore, can only be derived from experiments. For that purpose thermal and fluidic model states – according to the similitude theory – are generated and all needed parameters are measured. The results are generalised by physics' based methods for a later implementation in calculation algorithms.

Components and systems in the fields of power, process, environmental and automotive engineering can be developed on the basis of systematised material properties. The thermo-technical laboratory offers the possibility to characterise prototypical components, which are manufactured externally or in-house, with respect to their thermal or fluidic behaviour.

The results of the experimental studies are documented in terms of equations, characteristic maps or data sheets and hence ensure a reliable extrapolation on entire systems.

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THERMO-TECHNICAL LABORATORY

The business unit Energy and Thermal Management possesses a modern thermo-technical laboratory providing variable fluids and high-quality measurement technology:

- thermal and fluidic characterization of materials, structures and prototypic components,
- generation and temperature control (-40 °C … 600 °C) of defined gaseous flows by means of mass flow controllers (air, up to 250 l/min),
- generation and temperature control (-40 °C … 200 °C) of defined liquid flows (water, silicone oil),
- pressure, temperature, flow and velocity measurement of gases and liquids,
- thermal conductivity measurement of variable materials and cellular materials in particular
  - steady-state plate method,
  - transient hot disk method,
- high-performance, transportable thermography system (up to 2,200 °C, resolution 40 µm, picture frequency up to 60 Hz).

The long-time know-how in measuring as well as the excellent technical equipment in the business unit ensure topmost accuracy, generalisability and, therefore, the ability to extrapolate the gained results.

CONTACT

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5 *Experimental setup for cyclic heating and cooling of a thermal storage device,* 6 *Heat exchanger element based on metal foam,*
TITEL *Production route of paraffin-filled metal spheres serving as thermal storage devices with a test storage configuration (paraffin pellets → porous hollow spheres → filled and copper-plated spheres → numerical simulation → thermographic analysis)*