Fraunhofer IPM

Fraunhofer CPM

Switchable heat pipes
A new generation of thermal switches

Temperature control without sensor technology or control engineering

For future applications in e. g. electromobility, thermal switches must become more efficient and more cost-effective. We are researching new designs for heat pipe thermal switches in which water-binding sorbents are used.

Regulating the temperature of components in the fields of electromobility, battery technology or mechanical engineering becomes increasingly important as power density rises. Fraunhofer IPM is developing a new generation of thermal switches using switchable heat pipes, which provide an autonomous and efficient heat management system – without complicated sensor technology or control engineering. Using a switchable heat pipe, the effort for temperature control can be substantially reduced in many systems.

Efficiently regulating heat flow

Using thermal switches, heat flow can be activated, deactivated and regulated – quite similar to common electric switches. Conventional designs for thermal switches have several disadvantages: When in the "on" position, the thermal resistance is high, and the switches are large, often with a complex design and contain moving parts. For more widespread use, thermal switches must also become more efficient and cost-effective.

New thermal switch design

As part of the Fraunhofer Cluster of Excellence Programmable Materials CPM, Fraunhofer IPM is collaborating with other Fraunhofer institutes on a new generation of heat pipe based thermal switches. A heat pipe is a metal tube filled with a fluid in both its gas and liquid phase. When a heat source is placed on the hot side of the heat pipe, the temperature rises, causing the fluid to evaporate. Then, condensation occurs on the cold side of the tube, where the heat sink is located. Thus, heat transfer in a heat pipe takes place by transporting latent heat. This method of heat transfer is very effective and enables heat pipes with a very high level of thermal conductivity.

For this reason, heat pipes are generally well suited as the basis for thermal switches. In order to establish a heatpipe based thermal switch, water-binding sorbents with temperature-dependent regulating effects are

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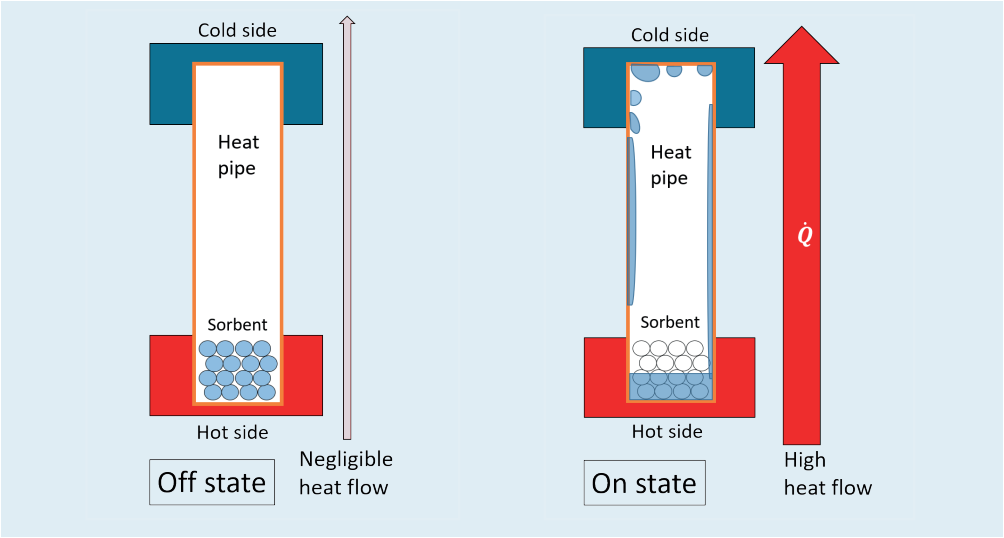
You have a specific question in regard to the temperature control of components and systems? We will work with you to find a heat pipe solution for your particular purpose – from the design to the prototype.

Of course, we are also happy to collaborate with thermal management solution providers.

Get in touch with us!



Thermal switches with temperature-dependent regulation using sorbents.

"Off" state: Working fluid absorbed by the sorbent, i.e., heat transfer is stopped.

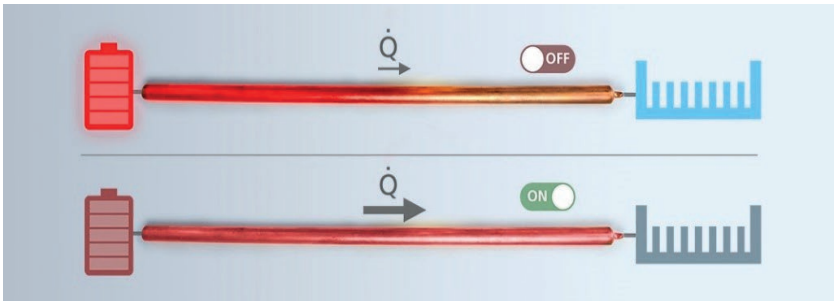
"On" state: Working fluid is released and enables a very efficient heat transfer in the heat pipe.

integrated into the heatpipe. The sorbents can take on water-binding or non-binding properties. Switching between these properties occurs at defined transition temperatures, which can be adjusted by varying the chemical composition of the sorbent. In its water-binding state, the sorbent absorbs the liquid, which is then no longer available for the evaporation and condensation processes. This stops the heat transfer process, cutting off heat transport more or less completely ("off" state). Above the transition temperature, the absorbed water is released, latent heat transfer can continue through evaporation and condensation processes, and the thermal switch is turned back to the "on" state. A patent has been registered for the thermal switch design described here.

Straightforward thermal management for many different purposes

Switchable heat pipes can be used for a variety of purposes. For example, battery systems, fuel cells and other systems function best at a certain "comfort temperature". Not controlling the systems' temperatures means diminishing their capacity, performance and service life. Using a switchable heat pipe, temperature control requirements can be substantially reduced. Until the desired operating temperature is reached, the switchable heat pipes transfer almost no heat; if a certain operating temperature is exceeded, the "on" state is activated and excess heat is effectively dissipated. This all takes place automatically, without the need for external intervention or complex sensor technology and control engineering.

The switchable heat pipes are therefore also suitable as "thermal emergency switches", which can dissipate heat if a critical temperature is exceeded.



Switchable heat pipes are compact and do not require any moving parts. They are easy to integrate and guarantee a very high heat transport capacity.

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