Fraunhofer ISE

Press Release

New Materials with Promising Characteristics Excite Solar Energy Researchers

Fraunhofer ISE Develops Highly Porous Coatings for Improved Performance of Cooling Systems and Heat Pumps

Researchers at the Fraunhofer Institute of Solar Energy Systems ISE have successfully coated various components with highly porous metal organic frameworks, or MOFs, which have the largest inner surface area of any material known. The industrially useful coating process used on these components has applications in heating and cooling systems, the catalytic manufacturing of chemical materials, gas and liquid detectors and medical technology, among others.

"Metal organic frameworks consist of a metal complex and an organic linker. These materials have typical inner surface areas of up to 4000 m² per gram and can bind up to 1.4 grams of water per gram material," explains Dr. Stefan Henninger, Head of the Sorption Materials Group at Fraunhofer ISE. "Also, they can be implemented modularly like LEGO blocks and used, for example, in solar cooling systems or compact thermal heat pumps. In the past, the material has been used in loose grain configuration as a filling between e. g. lamella heat exchangers. Now we have developed two patented processes in which we can apply different MOFs or other adsorbents directly onto the heat exchanger structures. This not only increases the cooling or heating efficiency of the system but also makes the unit much more compact.

In many sorptive dehumidification processes for air or other gases, the water vapor is adsorbed on the inner surface area.

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The heat generated by this process can be used or must be dissipated. The heat transfer between the MOF granulates – when used as filling – is limited due to the point contacts, thus strongly reducing the speed of the process. If, however, the MOF material is deposited as a thin layer on metal lamellae, the heat conductivity is significantly improved thereby increasing the system efficiency. At present, the dimensions of thermally driven heat pumps are equivalent to decent sized fridge-freezers. In the future, wall-mounted systems, as by compact gas heaters, might be possible.

Not only for buildings, but also in many other fields of application where reversible chemical and physical heat conversion processes take place, these novel coatings signal in a new revolution. Chemical processes often use catalysts with large inner surface areas. When carriers with good heat conductivity characteristics are coated with porous materials such as MOFs or zeolites, the flow rate or the temperature stability can be improved. In gas detectors, miniscule amounts of undesirable gases can be easily detected by a change in color or an increase in temperature. In the field of medical engineering, one can use coatings, for example, as a shield against bacteria.

The particular challenge for the Fraunhofer researchers was to deposit the material (which exists as powder in its original form) onto the surface of heat conducting structures. At Fraunhofer ISE, Felix Jeremias successfully developed a method for the direct crystallization of MOFs onto a metal carrier without using binders. As part of his diploma thesis, Harry Kummer developed an extremely versatile, binder-based coating that can be applied within a simple dipping method. He received the 2nd Hugo Geiger Prize of the Fraunhofer-Gesellschaft in 2012 for this development. The R&D work in this area was supported in different projects by the Federal Ministry of Economics & Technology BMWi. First prototypes are on display at the Energy Storage in Düsseldorf

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(25.-27.3., Foyer, B11) and the Hannover Trade Fair (7.-11.4., Hall 13, Stand C10).

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Application of highly porous metal organic frameworks (MOFs): Copper finned-tube heat exchanger by direct crystallization of copper trimesate. ©Fraunhofer ISE

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Industrial sized air-to-air heat exchanger with a binder-based coating using a zeolite-type material for the air-conditioning of buildings.
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