Frontier Chemistry Center
フロンティア化学教育研究センター　講演会

演 題：**Adsorptive Heat Pumps**
- Can MOFs replace existing sorbents? -

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場 所：工学部フロンティア応用科学研究棟 2F レクチャーホール（鈴木章ホール）

共 催：北海道大学
「物質科学フロンティアを開拓する Ambitious リーダー育成プログラム」

Globally about one-third of the energy consumption goes into heating and cooling of *e.g.* houses and buildings. Adsorption driven heat pumps and chillers are very well suited to reduce this energy consumption and can even use low-grade waste heat or sustainable solar energy in combination with environmentally benign working fluids.
Metal Organic Frameworks, MOFs, are porous crystalline materials built up from inorganic clusters connected by organic ligands in 1, 2 or 3 dimensions. Their rich variety of topologies and various options for functionalization hold potential for application in a plethora of fields. They offer the materials scientist an outstanding platform to design new materials with superior properties.
Here, the application of MOFs for adsorption chillers (AC) and adsorption heat pumps (AHP) is explored and their performance is compared with classical sorbents currently applied (activated carbon, zeolites and silica) [1].
Preferred working fluids are water (high heat of condensation), methanol and ethanol (both can be used below 0^{o} Celsius), all having sufficient vapour pressure in the temperature range of interest.
Important properties the MOFs have to comply with in relation to heat pumps are inevitably a long term stability towards the working fluid, a steep uptake in the relative pressure range of 0.05-0.4, easy desorption (no hysteresis), a good volumetric adsorption capacity, and an adsorption enthalpy close to the enthalpy of condensation.
Various MOFs have been identified that comply with these requirements. The most common water adsorption mechanism will be discussed [2]. For CAU-10H, however, the water uptake resembles a phase change, with constant adsorption enthalpy and an entropy change pointing at a phase between water and ice [3,4].
Both for AC (CAU-10H [3]) and AHP (MIL-160 [5]) certain MOFs reveal Coefficients of Performance (COP) that are better than current materials and they need smaller temperature windows for operation (difference between adsorption and regeneration temperatures).
Lastly the application of CAU-10H as a coating on a heat exchange surface is presented and the thermal adsorption cycling performance is compared with that of a powder sample.

1. M. M.F. de Lange, K.J.F.M. Verouden, T.H.J. Vlugt, J. Gascon, F. Kapteijn, *Chem. Reviews*, **2015** DOI: 10.1021/acs.chemrev.5b00059
2. M. F. de Lange, J. J. Gutierrez Sevillano, S. Hamad, T. J. H Vlugt, S. Calero, J. Gascon, and F. Kapteijn. *The Journal of Physical Chemistry C* 117 (**2013**) 7613-7622.
3. M. F. de Lange, C. P. Ottevanger, M. Wiegman, T. J. H. Vlugt, J. Gascon and F. Kapteijn, *Cryst.Eng.Comm.* 17 (**2015**) 281-285.
4. M. F. de Lange, T.Zeng, T. J. H. Vlugt, J. Gascon and F. Kapteijn, *Cryst.Eng.Comm.* 17 (2015) 5911–5920.
5. Cadiau *et al.*, *Advanced Materials* 27 (**2015**) 4775–4780.

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