Efficient solar-driven water harvesting from arid air by MOF-based composite sorbent

With the support by the Innovative Research Group Project of National Natural Science Foundation of China and the National Key R&D Program of China, the research team led by Prof. Wang RuZhu (王如竹) at the Research Center of Solar Power & Refrigeration MOE China, Shanghai Jiao Tong University recently reported a high-performance composite sorbent for efficient solar-driven water harvesting from arid air, which was published in *Angew Chem Int Ed* (2020, DOI: 10.1002/anie.201915170).

Freshwater scarcity is one of the great challenges worldwide, especially for people living in landlocked and arid regions. Since there is a large amount of water vapor existing in atmospheric air though the content in arid regions is much smaller than that in coast regions, sorption-based atmospheric water harvesting (AWH) is regarded as an appealing way to extract water moisture from dry air (RH～20%—30%). However, traditional sorbents suffer from the low water sorption capacity and have slow sorption-desorption kinetics. By comparing the working performance of typical inorganic hygroscopic salts, Wang's group found out lithium chloride (LiCl) has the highest water uptake capacity. Although the pure LiCl shows high equilibrium water uptake, it would become bulk agglomerated crystals after several sorption cycles, and even lose water sorption capacity because of the very poor mass transfer, thus limiting direct applications in AWH.

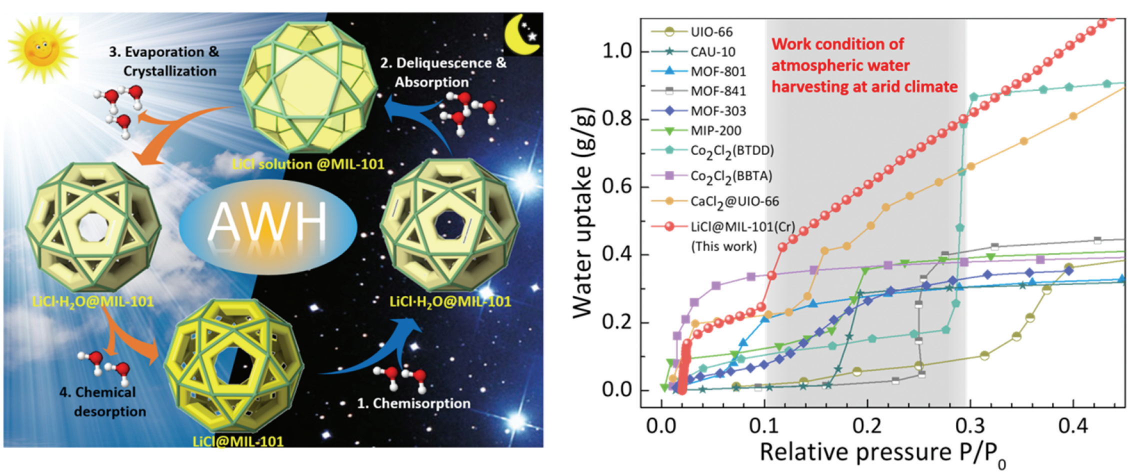

Figure Efficient solar-driven water harvesting from arid air and sorption capacity of LiCl@MIL-101.

To improve the water sorption kinetics and yield stability of LiCl, Dr. Li TingXian (李廷贤) and Prof. Wang reported a composite sorbent prepared by confining LiCl in a metal—organic framework matrix (LiCl@MIL-101(Cr)) with an ions-infiltration method. Benefiting from the large amount of ordered nanoscale pores of the MOF, the synthesized composite sorbent has high loading of 51 wt% LiCl, while the MOF matrix maintains 1/3 vacant pores for storing captured water. The composite sorbent exhibits fast water sorption kinetics and a high water sorption capacity up to 0.77 g/g under typical arid working conditions (30% RH at 30℃), which is the highest value among the reported MOFs and MOF-based composite sorbents for AWH under arid working conditions. They demonstrated a lab-scale AWH device with LiCl@MIL-101(Cr) capable of high AWH performance with 0.70 $kg_{water}/kg_{material}$ under laboratory conditions and 0.45 $kg_{water}/kg_{material}$ under outdoor natural sunlight conditions. Their work provides a promising composite sorbent to realize atmospheric water harvesting in arid regions powered by natural sunlight without additional energy input.