

# DEVELOPMENT OF ADVANCED MATERIALS FOR ADSORPTION THERMAL BATTERY

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Adsorption thermal battery, as one of the three thermal energy storage (TES) technologies, can reduce fossil fuel consumption, which is still dominant in building space heating, by shifting some of the solar energy collected in summer to winter. This technology uses reversible sorption processes of gases in solids, for example water sorption on porous solids. The efficiency of the sorption technology is determined by the performance of the adsorbent, which should have a high sorption capacity and, consequently, a high energy storage density, a low regeneration temperature, stability under humid conditions even at temperatures up to 120 °C, and rapid heat and mass transfer.

The current research focuses on the development of efficient water adsorbents with enhanced water adsorption capacity and hydrothermal cycling stability. The water adsorption behaviour of porous adsorbents, as one of the most important properties of water adsorbents, depends on the structure and chemical composition of the porous material, the presence of charged species, the degree of hydration, and the synthesis method.

The developments in innovative water adsorbents such as nanoporous hierarchical aluminophosphates and composites consisting of confined salt hydrates in various mesoporous matrices, and traditional zeolite with improved hydrophilic behaviour for adsorption thermal battery will be discussed. The emphasis of our research has been on the environmentally friendly synthesis and the study of the structure-property relationship. Among all microporous aluminophosphate water adsorbents, the aluminophosphate with LTA topology has so far exhibited the highest energy storage density (527 kWh/m<sup>3</sup>) and excellent cycling stability (the water adsorption capacity decreases by less than 2 wt% after 40 adsorption/desorption cycles) [1]. Moreover, the composite of LiCl and mesoporous  $\gamma$ -alumina can achieve almost three times higher energy storage density under similar working conditions [2].

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[1] Krajnc et al., *Adv. Energy Mater.*, 7 (2017) 1601815.

[2] Ocvirk et al., *Energies*, 14 (2021) 7809.