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Research article

Composite sorbents "calcium chloride inside alumina and carbon mesopores" for thermochemical energy storage

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Supplementary

1. Samples characterization

1.1. Tain-Calvet calorimetry

The calorimeter Tian-Calves used for measuring the immersion heat has been described elsewhere[1]. A dry sample of the pristine matrixes was placed into a measuring cell filled with distilled water or 3M aqueous solution of $CaCl_2$ similar to that used for impregnation (the measurements were performed by Dr. Y.D. Pankratiev). The samples were preliminary dried by heating at 200 ºC for 10 h followed by cooling to the initial test temperature. The sample mass was 10 mg. Care was taken to ensure that during the sample placing in the calorimeter it did not absorb moisture and its temperature was not altered. Indeed, during this procedure, the zero line of the calorimeter did not undergo noticeable changes. The heat release usually ceased within 15–20 min. The maximum error of the calorimeter was 3%.

[1] Pankratiev YD, Tanashev YY, Kulko EV, et al. (2006) Heat of wetting of aluminum hydroxide obtained by thermal activation of hydrargillite. *Rus J Phys Chem* 80: 1037–1043. https://doi.org/10.1134/S0036024406070077

Table S1. Heat Q_{im} of immersion in water and 3M aqueous solution of $CaCl_2$ for the studied activated alumina and Sibunit.

Solid	Liquid	I_{im}, J/m^2	Error, %
Alumina	Water	0.290	2.1
	$CaCl_2$ solution	0.331	2.7
Sibunit	Water	0.0324	0.9

1.2. Powder XRD analysis

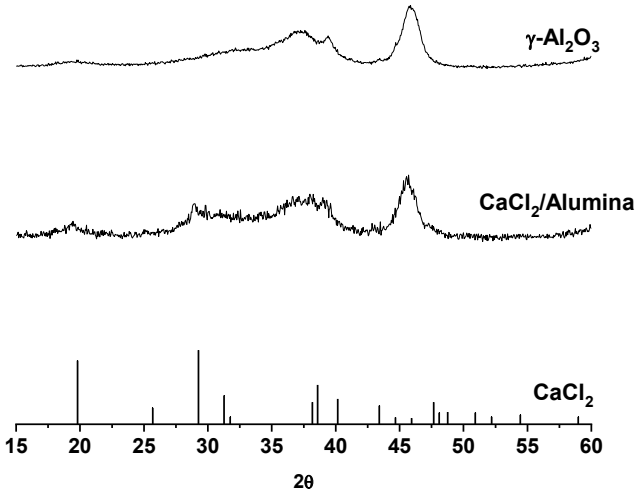

Figure S1. XRD patterns of alumina A1 and the composite $CaCl_2$/Alumina, as well as theoretical bar diagram for monocrystalline $CaCl_2$[2].

[2] Veselovskaya JV, Adsorption properties of composite ammonia sorbents based on dispersed chlorides of alkaline earth metal. *PHD thesis*. Boreskov Institute of Catalysis, Novosibirsk.2011

1.3. SEM

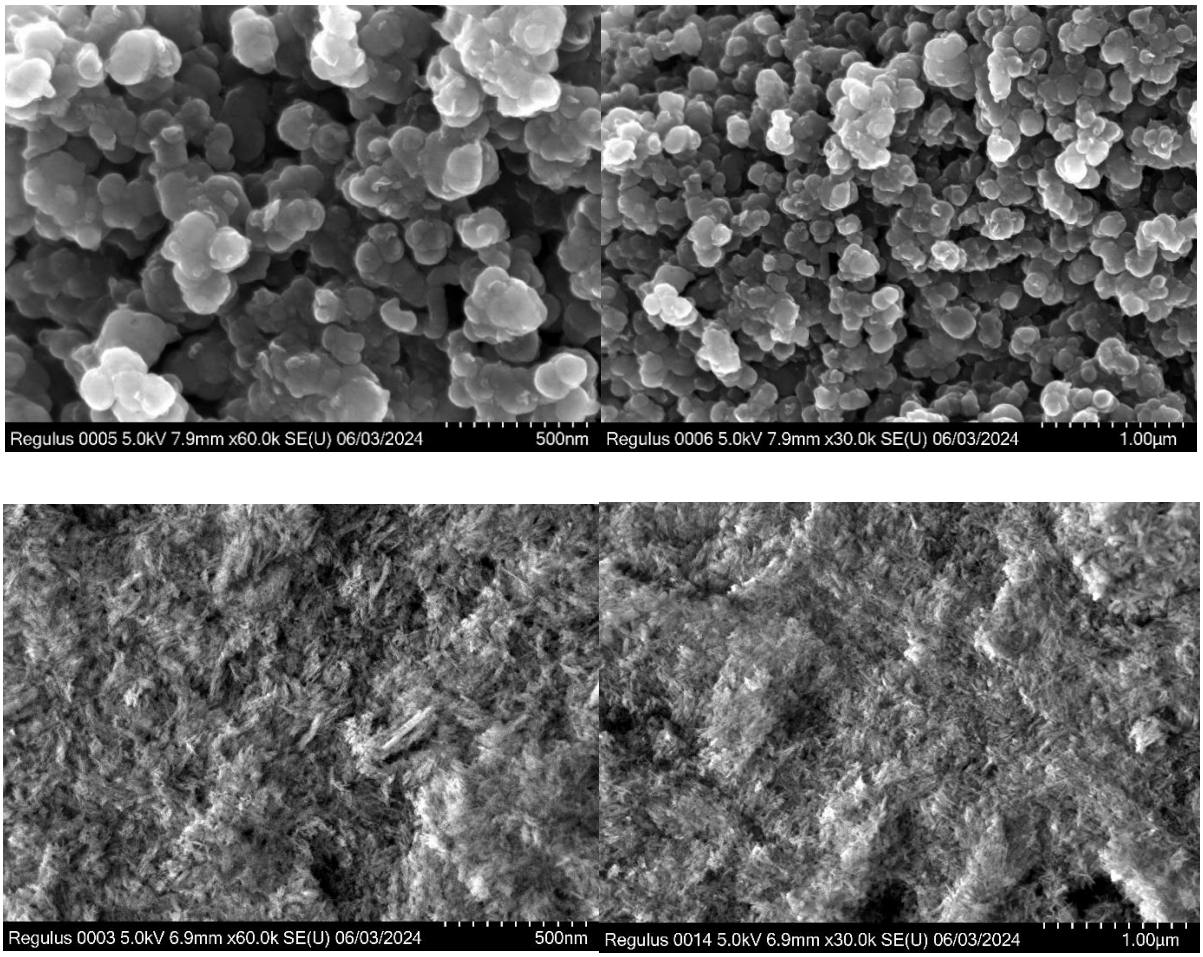

Figure S2. SEM images of $CaCl_2$/Sibunit (top) and $CaCl_2$/Alumina (bottom) composites.

2. Characteristic curves of water adsorption

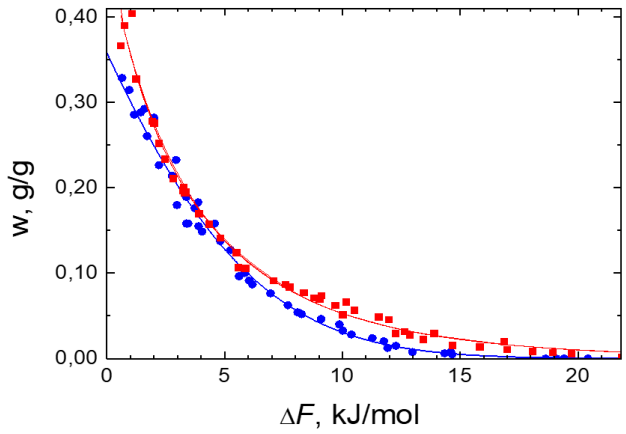

Figure S3. Characteristic curves $w(\Delta F)$ of water sorption on the $CaCl_2$/Alumina (■) and $CaCl_2$/Sibunit composite (●). Solid line—approximation by Eq (2).

3. *Energy storage capacity*

The total heat storage capacity of the sample was measured using a DSC 404 C Pegasus calorimeter (Netzsch). Before measurements, the calorimeter was calibrated as follows. Temperature calibration was performed using the melting point of a number of metals (standards): In, Bi, Sn, Zn. Calibration of the device's sensitivity was performed using the thermal effect of melting of the same metals. Each metal was measured at the factory settings of the calorimeter 3–4 times, and the average value was calculated. The obtained data were entered into the proteus analysis program, after which the values were automatically recalculated. The resulting calibration curves were saved and used for measurements.

A sample weighed 20 mg was placed into a standard aluminium crucible, saturated with water vapor, and hermetically sealed. Before measurements, a small hole was made in the crucible lid, then the sample was placed in the calorimeter and heated to 320 °C at a rate of 5 K/min. The results obtained were processed using standard Proteus Analysis software. Three measurements were made, and the average value was calculated.

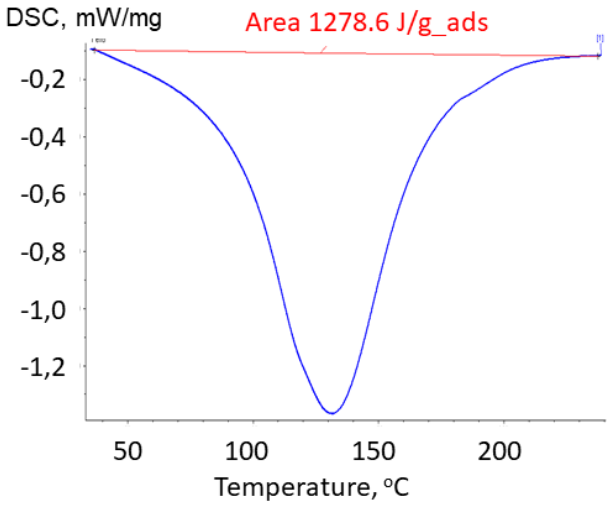

Figure S4. DSC curves for $CaCl_2$/Alumina saturated with water.