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Hydrogen Storage and Dynamics in Clay materials

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Hydrogen storage technologies play an important and crucial role in the so-called “hydrogen economy”. However, clay minerals have poorly been studied for this purpose, while they possess valuable properties (stability, low cost, green material) to be exploited in this domain.
We have recently studied H2 adsorption on synthetic smectite, specifically laponite and its gel (before hydrothermal treatment) where nickel ions are inserted into the structure (Fig.1(a)). Obtained X-ray scattering (Fig. 1(b)), the local structure of the gel, noted gel-Ni-laponite, is shown to be similar to that of Ni-laponite, while long-distance order is significantly reduced. The adsorption isotherms (Fig.1(c)) reveal a higher sorption of gel than that of laponite.

Figure 1. Link: https://ibb.co/DLg2F12

Inelastic neutron scattering (INS) is extremely useful at probing locally the direct vicinity of adsorbed molecular H2. The INS spectrum of a free H2 molecule is characterized at low temperature by a sharp and well-defined rotational feature at an energy of 14.7 meV corresponding to the transition of H2 from a para- (molecular spin S = 0, angular momentum J
= 0) state to an ortho- (S = 1, J = 1) state. The para-to-ortho transition line J01 has a three-fold degeneracy which is lifted as a function of the local symmetry of the adsorption site, with line-shifts that are dependent on the interaction between the H2 molecule and the host surface.
We will present here the results obtained on the gel precursor using the spectrometer PANTHER at the ILL (fig. 1(d)). At 41K, well above the solidification temperature of bulk H2, the J01 peak exhibits a fine structure which can be can fitted by two gaussian lines with an intensity ratio of 2:1 (low energy component: high energy component, fig. 1(d)). The splitting is in line with 1D hindering (H2 axis lying parallel to a surface). Upon further cooling, other lines appear until bulk-like hydrogen signal becomes progressively visible.

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