Hydrogen Spin Conversion Catalyzed by MOFs

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Diatomic molecular hydrogen has two quantum states, ortho-H_2 (↑↑) and para H_2 (↑↓), according to the relative orientation of nuclear spins and the equlibrium ratio of two states are dependeent on the temperature (e.g., 75 : 25 at room temperature and 0.18 : 99.82 at 20 K). Ortho-H_2 has has higher energy state than para-H_2 and release its energy (14.7 meV or 1.42 kJ/mol) as heat when it is converted into para-H_2. Liquid hydrogen which has been condensed without spin conversion catalysis (ortho to para) contains almost the same composition (~75%) of ortho-H2 and cause a boil-off of liquid by releasing the heat of conversion (ortho-H_2 → para-H_2) until the equilibrium composition (0.18%) is reached. Thus a rapid conversion of ortho-to-para hydrogen by magnetic catalyst is very essential technology for the utilization of liquid hydrogen.

MOFs having magnetic (transition metal or rare earth metal) ions have a multi-function for hydrogen utilization, storage of H_2 and magnetic catalysis of ortho-to-para conversion. M-MOFs (magnetic ions loaded MOFs) of chief cost and efficient functions have ben investigated and a few ezamples will be presented.