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## Hydrogen storage in the iron series of porous Prussian blue analogues

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### ABSTRACT

The hydrogen storage has been studied in several series of porous Prussian blue analogues but not in the iron one,  $T_3[Fe(CN)_6]_2$  with  $T = Mn, Co, Ni, Cu, Zn, Cd$ . In this contribution the study of the  $H_2$  adsorption in that series of porous solids is discussed. For comparison, the  $H_2$  adsorption isotherm in  $Fe_4[Fe(CN)_6]_3$  was also recorded. All the samples to be studied were characterized from energy-dispersed spectroscopy, X-ray diffraction, infrared, Mössbauer, and thermogravimetric data. The cavity volume to be occupied by the hydrogen molecule was estimated from the amount of water molecules found within the cavity. The obtained value for the cavity volume was then used to calculate the density for the hydrogen storage within the cavity. The obtained density values remain below the value corresponding to its liquid state (71 g/L).

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## 1. Introduction

Hydrogen is being considered an alternative to fossil fuel derivatives as secondary energy bearer for mobile technologies [1,2]; the hydrogen oxidation liberates 142 kJ/g, 3 times the value obtained from gasoline (47.5 kJ/g). Unlike to hydrogen, which can be produced from the water splitting and whose oxidation byproduct is water, fossil fuels derivatives are non-renewable energy sources and their combustion liberates carbon dioxide, which is responsible for the global warming and of the related climate changes. The solar energy accumulated by nature in about 400 millions of years as fossil fuels will be consumed by the human kind in scarcely three centuries [3]. These facts explain the urgency in the hydrogen technology development, particularly for hydrogen production by the water splitting using solar radiation, its storage and then its use through highly efficient and economically viable

fuel cell devices. Of these three targets the availability of an appropriate storage method is probably the main challenge [4]. Hydrogen is a small molecule with a low critical temperature ( $T_c = 32.97$  K) and above that temperature it is always found in gaseous state. For a pressure of 345 atm, a density of 22 g/L is obtained, relatively low compared to 71 g/L for the liquid state. The storage in liquid state for massive applications appears to be also impractical since the liquefaction process consumes about 40% of the energy to be generated.

Several methods are being studied for hydrogen storage, among them the hydride formation in light weight materials [5,6], high pressure  $H_2$  sequestering within molecular cages (clathrates) [7] and  $H_2$  adsorption in nanoporous solids [8–10]. All these storage methods have limitations and none of them satisfies the established technological requirements [9,11]. The adsorption in nanoporous solids is highly attractive because of the high process reversibility, a feature up to date

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