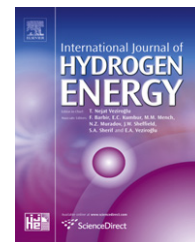




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High density hydrogen storage in nanocavities: Role of the electrostatic interaction

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ABSTRACT

High pressure H₂ adsorption isotherms at N₂ liquid temperature were recorded for the series of cubic nitroprussides, Ni_{1-x}Co_x[Fe(CN)₅NO] with x = 0, 0.5, 0.7, 1. The obtained data were interpreted according to the effective polarizing power for the metal found at the surface of the cavity. The cavity volume where the hydrogen molecules are accumulated was estimated from the amount of water molecules that are occupying that available space in the as-synthesized solids considering a water density of 1 g/cm³. The calculated cavity volume was then used to obtain the density of H₂ storage in the cavity. For the Ni-containing material the highest storage density was obtained, in a cavity volume of 448.5 Å³ up to 10.4 hydrogen molecules are accumulated, for a local density of 77.6 g/L, above the density value corresponding to liquid hydrogen (71 g/L). Such high value of local density was interpreted as related to the electrostatic contribution to the adsorption potential for the hydrogen molecule within the cavity.

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1. Introduction

The world economy formed in the last century is mainly based on the use of fossil fuels as energy source but, such development is untenable because the limited availability of these non-renewable resources and leads to an irreversible environmental catastrophe. The combustion of fossil fuels and their derivatives produces the emission of large amounts of carbon dioxide which is responsible for the global warming and related climate changes [1]. From these facts, the idea of an economy based on hydrogen as energy bearer has emerged and consolidated in the last decades [1–3]. The hydrogen oxidation liberates 286 kJ/mol, three times the value obtained from gasoline, and produces an environmental friendly byproduct, water. The main challenge to have an energetic technology based on hydrogen as secondary energy bearer

instead fossil fuels derivatives, is probably the non-availability, up to date, of an appropriate hydrogen storage method. Hydrogen is a molecule of very low critical temperature (32.97 K) to be storage in liquid state for massive technological applications. Such feature of hydrogen also explains the difficulties found for its storage in high pressure vessels. From these facts, several alternative storage routes are being evaluated, among them the hydride formation in light weight materials [4,5], H₂ sequestering in molecular cages (clathrates) [6], and H₂ adsorption in solids of extended surface, mainly nanoporous materials [7,8]. This last method is particularly attractive because of its reversibility, a required feature of any viable H₂ storage technology.

The hydrogen molecule can be adsorbed through three types of adsorption forces [9]: 1) dispersive interactions, whose strength depends on the surface electron density, 2)

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