Hydrogen storage in porous materials, current status and future challenges

Michael Hirscher

Max Planck Institute for Intelligent Systems (formerly MPI for Metals Research)

Heisenbergstr. 3, D-70569 Stuttgart, Germany

email: hirscher@is.mpg.de

Hydrogen storage in porous materials gained considerable interest, since in the past 15 years many new coordination polymers or framework materials have been synthesized, which show a permanent ultra-high porosity and an extremely large specific surface area [1-3]. Different classes of these novel highly porous structures, e.g., metal-organic frameworks (MOFs), zeolitic imidazolate frameworks (ZIFs) or covalent organic frameworks (COFs), have been extensively studied for applications in gas storage. Beside their large surface area, these crystalline frameworks possess well-defined pore sizes having a uniform distribution.

Typically, the interaction of the adsorbent and hydrogen molecules is simply governed by van der Waals forces and therefore high storage capacities can only be achieved at low temperatures. As known from activated carbons, the maximum hydrogen uptake at high pressure and 77 K shows an almost linear correlation with the specific surface area even for these nanoporous framework materials consisting of various other elements than carbon [4]. Furthermore, frameworks possessing smaller pores show typically a higher heat of adsorption. Both, maximum hydrogen storage capacity and heat of adsorption have to be considered to optimize the materials for their potential application [5]. Furthermore, for technical application the key parameter is the usable capacity, which is the amount of hydrogen that can be delivered between the maximum pressure of the tank system and the back pressure required by the fuel cell [6]. The presentation will give a short overview of the current status and discuss the future challenges [7].

References

[1] G. Férey, Chem. Soc. Rev., 37 (2008) 191.
[2] S. Kitagawa, R. Kitaura, S.-i. Noro, Angew. Chem. Int. Ed., 43 (2004) 2334 –2375.
[3] O.M. Yaghi, et al., Nature, 423 (2003) 705-714.
[4] M. Hirscher, Angew. Chem. Int. Ed. 50 (2011) 581-582.
[5] M. Hirscher, M. Schlichtenmayer, J. Mater. Chem., 22 (2012) 10134-10143.
[6] M. Schlichtenmayer, M. Hirscher, Appl. Phys. A (2016) in press.
[7] D.P. Broom et al., Appl. Phys. A (2016) 122:151.