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Carbon-based nanostructures for hydrogen storage.

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Hydrogen is considered to be the ideal energy carrier for future automotive, industrial and domestic applications. The unique characteristics that hydrogen exhibits, such as abundance in nature, convenience for transportation, safety, environmental friendliness and greater efficiency from other fossil fuels, provide an alternative in order to deal with the greater issues of this century, the environmental pollution and the energy problem.

Production, storage, distribution and usage are the main aspects included in hydrogen technology. However, storage is the most important challenge, due to the low boiling point of hydrogen (-252,87oC) and its low density in gaseous state (0,08988 g/L at 1 atm). The hydrogen can be stored in gaseous, liquid and solid state. The research is now focused to materials with the ability to chemically absorb and reversibly release hydrogen. Solid state hydrogen storage is the most promising due to the various materials that can be used as absorbers, such as Metal Hydrides, Complex Hydrides, Intermetallic Compounds and Carbon-based materials. According to the U.S. Department of Energy, some specific material properties are required for larger commercial storage-applications. The optimum hydrogen-storage materials should have a minimum hydrogen gravimetric capacity of 6,5 wt%, density of 65 g/L hydrogen, decomposition temperature between 60oC to 120oC, low desorption temperature and absorption pressure (few bars in room temperature), low cost and non-toxicity. Until today, none of the above material categories satisfies all the requirements for hydrogen storage applications.

In the present study carbon nanostructures, such as Single-walled (SWNT) or Multi-walled carbon nanotubes (MWNT), with different diameters, functional groups and impurities level will be studied. At the same time high surface area (m2/g) graphene sponge will be critically compared with the tubular structures. Beyond the benchmark materials, as those mentioned above, high surface area nanofibers composed of carbon blends will also be investigated and critically compared with the stand alone carbon nanostructures. A correlation between the porosity, structure, morphology as will be investigated based on porosimetry, x-ray diffraction and raman spectroscopy and scanning electron microscopy and metal-doping level (EDX) with their performance in terms of hydrogen adsorption will be established.