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Innovative Carbon Based Materials for Solid State Hydrogen Storage and Energy Storage †

Milanese Chiara [1], Alessandro Girella [1], Amedeo Marini [1], Daniele Pontiroli [2], Mattia Gaboardi [3], Giacomo Magnani [2], Mauro Riccò [2]

[1] Pavia Hydrogen Lab, Chemistry Department, University of Pavia, Italy
[2] Nanocarbon Laboratory, Dipartimento di Scienze Matematiche, Fisiche e Informatiche, Università Degli Studi di Parma, Italy
[3] Elettra Sinctrotrone Trieste SCpA, Basovizza, 34012, Italy
* Correspondence: chiara.milanese@unipv.it;
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Abstract: Alkali cluster-intercalated fullerides (ACIF) consist of crystalline nanostructures in which positively charged metal clusters are ionically bond to negatively charged C_{60} molecules, forming charge-transfer salts. These compounds have been recently investigated with renewed interest, appearing as a novel class of materials for hydrogen storage, thanks to their proven capability to uptake reversibly high amounts of hydrogen via a complex chemisorption mechanism. In this presentation, after a short summary on the hydrogen storage topic, the synthesis, the structural investigation, and the hydrogen storage properties of Li, Na, and mixed Li-Na clusters intercalated fullerides belonging to the families $Na_xLi_{12-x}C_{60}$ ($0 \leq x \leq 12$) and $Na_xLi_{6-x}C_{60}$ ($0 \leq x \leq 6$) will be presented. By manometric and thermal analyses, it has been proved that C60 covalently binds up to 5.5 wt% H_2 at moderate temperature and pressure, thanks to the catalytic effect of the intercalated alkali clusters. Moreover, the destabilizing effect of Na in the co-intercalated $Na_xLi_{6-x}C_{60}$ compounds leads to an improvement of the hydrogen-sorption kinetics by about 70%, linked to a decrease in the desorption enthalpy from 62 to 44 kJ/mol H_2. The addition of Pt and Pd nanoparticles to Li fullerides increases up to 5.9 wt% H_2 the absorption performances and of about 35 % the absorption rate. The ammonia storage properties of Li_6C_{60} have also been investigated, resulting in quite appealing. Being the price of C_{60} quite high, cheaper C based materials are under examination. Porous biochar from agricultural waste is giving interesting results as electrode materials for high-performance supercapacitors.

Keywords: solid state hydrogen storage; C based materials; fullerene; fullerides.

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Conflicts of Interest

The authors declare no conflict of interest.