華南理工大學
South China University of Technology

16th International Symposium on Metal-Hydrogen Systems

MH2018

October 28-November 2, 2018
Guangzhou, China

Program Book

Abstract ID:031
MH2018 28 Oct - 2. Nov 2018 Guangzhou, China

Design of an optimized hybrid hydrogen storage reservoir with high capacity

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The commercial use of hydrogen as a fuel, especially for the transportation sector, is still precluded by the lack of a cost effective, efficient and safe method to store and deliver hydrogen. It is still a challenge to find a suitable hydrogen reservoir for the environmentally friendly fuel cell powered vehicles, or at least to reach an optimum trade-off between the requirements and the optimization of a method. In this regard, an alternative is the combination of a hydrogen pressure tank and hydride compounds. This hybrid method benefits from less severe hydrogen pressure conditions, easiness of thermal management and the further densification of hydrogen, increasing the volumetric capacity, owing to the presence of a hydride compound.

In this work, we present the conceptual design of an optimized hybrid tank for 0.5 kg H_2 to operate at room temperature and pressures between 10 and 350 bar of H_2. Laboratory experimental results for an AB_2 type material with high equilibrium pressures and adequate capacity leads to an optimized trade-off between hydrogen capacity, thermal management and cost of the hybrid tank as a whole. The full thermodynamic, kinetic and microstructural characterization of the hydride forming material allows the prediction of the tank's behavior based on finite elements simulations. Moreover, investigations on different alternatives to the traditional type III and IV reinforced vessels for high pressure are also shown.