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Review

A concise review on surface and structural modification of porous zeolite scaffold for enhanced hydrogen storage

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ABSTRACT

Investigating zeolites as hydrogen storage scaffolds is imperative due to their porous nature and favorable physicochemical properties. Nevertheless, the storage capacity of the unmodified zeolites has been rather unsatisfactory (0.224%–1.082% (mass)) compared to its modified counterpart. Thus, the contemporary focus on enhancing hydrogen storage capacities has led to significant attention towards the utilization of modified zeolites, with studies exploring surface modifications through physical and chemical treatments, as well as the integration of various active metals. The enhanced hydrogen storage properties of zeolites are attributed to the presence of aluminosilicates from alkaline and alkaline-earth metals, resulting in increased storage capacity through interactions with the charge density of these aluminosilicates. Therefore, there is a great demand to critically review their role such as well-defined topology, pore structure, good thermal stability, and tunable hydrophilicity in enhanced hydrogen storage. This article aimed to critically review the recent research findings based on modified zeolite performance for enhanced hydrogen storage. Some of the factors affecting the hydrogen storage capacities of zeolites that can affect the rate of reaction and the stability of the adsorbent, like pressure, structure, and morphology were studied, and examined. Then, future perspectives, recommendations, and directions for modified zeolites were discussed.

1. Introduction

Recently, research into the search for alternative sources of energy, particularly for the transportation and industrial sectors, has increased tremendously owing to the rapid depletion of fossil fuels, the associated environmental effluence from their combustion, and the recent increase in crude oil prices globally [1,2]. The use of green energy, like solar, and wind has fascinated much consideration due to the rising concerns about the problem of fossil fuels and ecological damage. Unfortunately, the production of these green energies is periodic and has many downsides, including poor power output. Similarly, the energy supply needs to catch up with its demand. As a result, energy storage has emerged as one of the key topics that will improve the use of sustainable energies for high-power, environmentally friendly energy sources in the present and the future [3–5]. Among the available energy storage technologies, hydrogen storage holds great potential for different applications, including vehicles, and other heavy-duty devices. Due to its substantial benefits, including its lightweight, high-burning heat, and relatively minimal environmental pollution, the usage of hydrogen as an energy carrier in an automobile or aviation turbine is a possible field of application [6]. However, a tool for secure and convenient handling, storage, and transportation is required. For this objective, several methods have been put forth. Currently, hydrides (metals and non-metals) have been seen as a potential and suitable candidate to be used for hydrogen storage,

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