Synthesis of $NiCo_2S_4$ for Electrochemical Hydrogen Storage Applications

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Abstract

The electrochemical hydrogen storage (ECHS) has become a viable strategy for effective and secure hydrogen energy management in the context of renewable energy sources and developing next-generation energy storage systems. Electrochemical hydrogen storage relies on reversible electrochemical reactions that allow hydrogen to be stored and released within electrode materials under mild operating conditions, in contrast to traditional hydrogen storage methods such as compressed gas cylinders or cryogenic liquid hydrogen [1][2]. Alloy-based materials have been predominantly utilized as electrode materials for electrochemical hydrogen storage over the past few years. However, due to challenges associated with their complex structures and synthesis processes, there has been a growing need to explore alternative, more reliable electrode materials for ECHS. Here, 2-dimensional layered double-hydroxide derived $NiCo_2S_4$ electrode materials were synthesized using a one-pot hydrothermal method, and their electrochemical hydrogen storage performance was evaluated using a three-electrode system. At 1 A g^{-1}, the synthesized $NiCo_2S_4$ exhibited a discharge capacity of 130 mAh g^{-1}, which is equal to a hydrogen storage capacity of 1.0 atoms g^{-1} (0.5 weight percent) and hence which is comparatively higher than the adsorbent based high pressure H_2 storage. The material also demonstrated excellent cyclic stability, retaining nearly 80% of its capacity after 100 galvanostatic charge/discharge cycles. Furthermore, the synthesized materials were characterized by Raman spectroscopy, FTIR, and FE-SEM to assess their structural, chemical, and morphological properties.

References

[1] H. Chauhan and A. Yadav. Int. J. Hydrogen Energy, 70 (2024) 756–768.
[2] X. Xu, Y. Dong, Q. Hu, N. Si, and C. Zhang. Energy and Fuels, 38, (2024) 7579–7613.

Figures

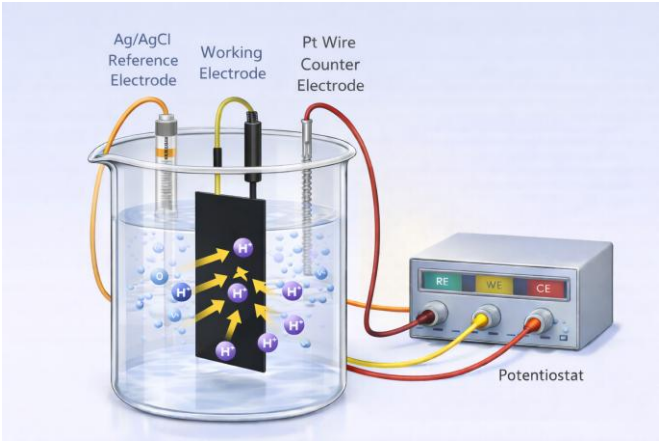

Figure 1: Schematic representation of the electrochemical hydrogen storage.