Efficient Hydrogen production with methanolysis on catalysts derived from waste materials

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Abstract

Energy is one of the most important needs for humanity. The world's energy need is provided from fossil fuels such as oil, coal and natural gas. However, with the increasing world population and rapidly developing industrialisation, the current energy demand is increasing day by day. The development of alternative energy sources is of great importance due to the increasing depletion of fossil fuels and environmental damage. Renewable high purity hydrogen has attracted attention as a clean and efficient energy source alternative to fossil fuels. Among various alternative technologies, hydrogen has attracted great interest in recent years due to its high gravimetric energy density and energy conversion without CO_2 emission. In recent years, hydrogen is obtained from methanolysis of borohydride species. Sodium borohydride ($NaBH_4$) is a highly advantageous material for providing pure hydrogen at room temperature due to its various advantages such as being very stable, non-flammable, non-toxic in nature and able to store hydrogen. Catalysts are of great importance in hydrogen production with $NaBH_4$. Metal-containing or metal-doped support materials have been developed as catalysts. Despite their high catalytic activity, these metal-containing catalysts are costly and have disadvantages due to their environmental impact. Therefore, metal-free catalysts have attracted the attention of the scientific world in recent years due to their advantages such as low cost, environmental friendliness and high activity. Metal-free catalysts such as activated carbon, zeolite, and glass frits, have high hydrogen production activities. These materials exhibited high catalytic activity in hydrogen production. In this study, the catalytic activities of activated carbon, zeolite, and glass frits catalytic activities of the composites was investigated. These materials were characterised by N_2 adsorption-desorption, Scanning Electron Microscopy (SEM-EDX), Transmission electron microscopy (C-TEM) and High Resolution transmission electron microscopy (HR-TEM), X-ray diffraction (XRD), X-ray photoelectron Sepctroscopy (XPS). Their catalytic performance as catalysts for H_2 production from methanolysis of $NaBH_4$ was investigated. Different methanol concentration, different amount of catalyst and different amount of $NaBH_4$ will be analysed to determine the optimum conditions. In addition, analyses were carried out at different temperatures and Arhenius equation were used to determine the activation energy. We achieved an HGR value of 30.000-100 000 mL/min.gcat and these results revealed that these materials are promising materials for hydrogen production.

Keywords: activated carbon, energy, hydrogen, methanolysis

References:

[1] Abdalla, Abdalla M., Shahzad Hossain, Ozzan B. Nisfindy, Atia T. Azad, Mohamed Dawood, and Abul K. Azad. 2018. 'Hydrogen Production, Storage, Transportation and Key Challenges with Applications: A Review'. *Energy Conversion and Management* 165 (June):602–27. https://doi.org/10.1016/j.enconman.2018.03.088.

[2] A l-Thabaiti, Shaeel Ahmad, Zaheer Khan, and Maqsood Ahmad Malik. 2019. 'Bimetallic Ag-Ni Nanoparticles as an Effective Catalyst for Hydrogen Generation from Hydrolysis of Sodium Borohydride'. *International Journal of Hydrogen Energy* 44 (31): 16452–66. https://doi.org/10.1016/j.ijhydene.2019.04.240.

[3] Attila, Özgün, Helen E. King, Florian Meirer, and Bert M. Weckhuysen. 2019. '3D Raman Spectroscopy of Large Zeolite ZSM-5 Crystals'. *Chemistry – A European Journal* 25 (29): 7158–67. https://doi.org/10.1002/chem.201805664.

[4] Colak, Tuluhan O., Cigdem Tuc Altaf, Valentina G. Minkina, Stanislav I. Shabunya, Mehmet Sankir, Nurdan Demirci Sankir, and Vladimir I. Kalinin. 2022. 'Efficient Hydrogen Generation with Co3O4@TiO2-g-C3N4 Composite Catalyst via Catalytic NaBH4 Hydrolysis'. *Catalysis Letters* 152 (9): 2779–88. https://doi.org/10.1007/s10562-021-03848-6.