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Gamma Irradiation Assisted Nickel Impregnation on Activated Carbon Derived from Water Hyacinth for Electrocatalyst Application

Water hyacinth (WH) is an invasive floating plant causing water pollution. However, its leaves contain a high cellulose content, which can be utilized as biomass to synthesize activated carbon. Thus, in this study, water hyacinth was subjected to the KOH activation process to obtain water hyacinth-based activated carbon (WH/AC). Moreover, as a novel method for nickel impregnation, gamma irradiation was proposed as an alternative to replacing the traditional method due to its high penetration power and energy. To obtain the best conditions for nickel impregnation, different absorbed doses of gamma-ray (0, 20, 100 kGy) were applied to commercial activated carbon (AC), denoted as 0-AC, 20-AC, and 100-AC, respectively. These samples were thoroughly characterized with BET, SEM-EDS, FT-IR, XRD, XPS, and Raman spectroscopy. The higher I_D/I_G ratio in Raman spectroscopy, implying the greater disorder of the sample and, consequently, the more incredible amount of nickel impregnated on the sample. The SEM images showed that the surface morphology of the activated carbon significantly changed, becoming more spherical in structure, and distributed after gamma irradiation. The BET surface areas of AC, 0-AC, 20-AC, and 100-AC were 717, 718, 789, and 798 m^2/g, respectively. As a result, the optimum absorbed dose for nickel impregnation is 20 kGy. Thus, a 20 kGy absorbed dose of gamma-ray was carried out in WH/AC. The activated carbon electrocatalysts were investigated for applying electrochemical carbon dioxide reduction reaction (CO_2RR) by linear sweep voltammetry (LSV). The 20-WH/AC electrocatalyst exhibited the highest efficiency compared to others. Further studies are needed to improve the efficiency of the electrocatalyst in the CO_2RR process. Finally, the results show that water hyacinth can potentially be used as a raw material in the production of nickel-impregnated activated carbon irradiated with gamma rays.

Keywords: Activated carbon; Water hyacinth; Gamma irradiation; Nickel impregnation; Electrocatalyst

Authors: Mr TONKAEW, Piyapat (Kamnoetvidya Science Academy); Ms DEECHAKAWAN, Nicharee (Kamnoetvidya Science Academy); Ms KANJANAKOSIT, Nichawadee (Kamnoetvidya Science Academy); Dr ANANTACHAISILP, Suranan (Kamnoetvidya Science Academy); Dr CHUTIMASAKUL, Threeraphat (Thailand Institute of Nuclear Technology (Public Organization)); Dr TANAGORN, Kwamman (Thailand Institute of Nuclear Technology (Public Organization))

Presenters: Mr TONKAEW, Piyapat (Kamnoetvidya Science Academy); Ms DEECHAKAWAN, Nicharee (Kamnoetvidya Science Academy); Ms KANJANAKOSIT, Nichawadee (Kamnoetvidya Science Academy)

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