CATALYTIC PROPERTIES OF DEPOSITED GRAPHENE OXIDE ON ALUMINUM OXIDE IN THE ETHENE HYDROGENATION REACTION

Nosach V.V,[1,2] *Bychko I.B.*[2]
[1] Institute of Physical Chemistry named after L. V. Pyzarzhevsky
National Academy of Sciences of Ukraine, Kyiv,
[2] Kyiv-Mohyla Academy National University; Kyiv.victorynosach@gmail.com

The hydrogenation of unsaturated hydrocarbons, exemplified by the hydrogenation of ethylene, displays the catalytic activity of carbon nanomaterials when reacting with molecular hydrogen [1]. Due to their high degree of crystallinity and developed surface, reduced graphene oxide (rGO) and its composites emerge as promising catalysts for hydrogenation reactions. This study focuses on investigating the catalytic properties of rGO supported on aluminum oxide in the ethylene hydrogenation reaction [2].

A series of nanocomposite samples with varying rGO loadings on aluminum oxide were prepared by impregnating Al_2O_3 with graphene oxide colloid (GO) followed by reduction with hydrogen. The rGO contents in the samples ranged from 0.005 mg/g to 20 mg/g. GO was synthesized via graphite oxidation, following a modified version of the Hammers method [3].

The catalytic activity of the samples was evaluated in a flow tube reactor, with chromatographic monitoring of the ethylene hydrogenation products. The reaction mixture comprised 90% H2 and 10% C_2H_4, and the reaction temperature ranged from 50°C to 400°C. Additionally, the samples were subjected to scanning electron microscopy (SEM) and Raman spectroscopy analysis.

SEM analysis confirmed that the applied graphene oxide, arranged in layered sheets, did not entirely cover the carrier's surface, even at higher concentrations. The sheet sizes ranged from 0.5 to 2 microns.

Raman spectroscopy revealed that the intensity ratio of the D and G lines (ID/IG) in the rGO/Al_2O_3 samples ranged from 1.20 to 1.65, indicating consistent defectiveness across different rGO concentrations.

The catalytic activity of the samples decreased with increasing rGO content. Notably, the sample with a rGO concentration of 0.025 mg/g exhibited the highest catalytic activity, with a rate of 5.05×10^{-4} $mol\cdot c^{-1}g^{-1}$, equivalent to 2.02 $mol\cdot c^{-1}g^{-1}$ of applied rGO.

In contrast, the sample with a rGO concentration of 20 mg/g displayed the lowest activity, with rates of 1.35×10^{-7} $mol\cdot c^{-1}g^{-1}$ and 2.69×10^{-8} $mol\cdot c^{-1}g^{-1}$, respectively. These findings suggest the significant role of hydrogen spillover in these systems.

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