Synthesis of Borophene and Determination of Its Hydrogen Storage Capacity Using QCM for Potential Applications in the Automotive Industry

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Borophene is a newly synthesized material that is considered superior in various properties. Due to the challenges of hydrogen storage and transportation, hydrogen energy has not fully developed. Borophene's hydrogen storage capacity has been explored in only a few theoretical studies. This work introduces the novel use of QCM to determine borophene's hydrogen storage capacity. A Quartz Crystal Microbalance (QCM) sensor was used due to its ability to measure gravimetrically. The use of QCM for determining borophene's hydrogen storage capacity is a novel approach introduced in this work. B12-borophene was synthesized using the ultrasonic exfoliation method, and the characterization was made using TEM, XPS, FTIR and XRD. The characteristic peaks of borophene were observed. In this study, the hydrogen storage potential of borophene was investigated using the QCM system, and frequency-time and mass-time graphs were plotted from the data. A 7.4% mass increase was observed in the first hydrogenation phase, which decreased to 7.0% in the second and further to 6.9% in the third. The 0.4% decrease between the first and second hydrogenations was attributed to hydrogen chemically bound to borophene. The 0.1% difference between the second and third hydrogenations was considered to be due to overall efficiency loss. The results indicate that the hydrogen storage capacity of borophene occurs both through physical adsorption and chemical bonding. However, data obtained from repeated hydrogenation processes revealed that hydrogen binds to borophene physically at a much higher rate than chemically. The study demonstrates borophene's hydrogen storage capacity, highlighting its applicability, sustainability, and profitability as an innovative material for future hydrogen storage.

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