Development of Novel Bi-functional Catalyst for LOHCs as Sustainable Hydrogen Storage and Transportation Applications

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Reducing greenhouse gas emissions is an important goal. Hydrogen is a potential renewable energy source; however, cost-effective storage and transportation of hydrogen pose challenges. In this context, the practical implementation of liquid organic hydrogen carriers (LOHCs) will be investigated. Currently two individual catalysts and reactors are needed for hydrogenation and dehydrogenation reactions. The study aims to prepare one catalyst in one reactor for both reactions. A series of catalysts was synthesized, x%Rh-y%M@CeO2, by dispersing Rh in combination with a variety of transition metals, M= Fe, Co, Ni, and Mn. Both processes were tested in a batch reactor, and GC-MS was used to identify the product conversion after the reaction. The highest conversion of toluene to methylcyclohexane (MCH) in the hydrogenation reaction was 84% and 100% selective using 10 mg of 0.5%Rh-10%Mn@CeO2 at 80°C under 40 bars of H2(g). while, the dehydrogenation reaction using 10 mg of same catalyst achieved 80% conversion and 100% selectivity of MCH to toluene at 200°C, 0 bars of H2(g). In contrast, other studies showed %>90 conversion and <90% selectivity however, using two different catalysts and reactors. Optimization of reaction conditions, temperature, pressure, catalysts' weight, and time duration of reactions was performed to improve overall product yield. The prospect of stable recyclability was tested over five runs, yielding consistent conversion and selectivity results. This study shows promising development for efficient and reversible catalyst demonstrated promising performance as an alternative solution for hydrogen storage and transportation processes.

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