Catalytic Liquid Organic Hydrogen Carrier (LOHC) System (Yeda)

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David Milstein, Chemistry, Organic Chemistry

Summary

A novel Liquid Organic Hydrogen Carrier (LOHC) system provides an inexpensive, safe and clean solution for loading and unloading of hydrogen on demand with high potential hydrogen storage capacity. The thriving need for fossil fuels alternatives as energy resources in order to maintain the fast development of human civilization has led to the introduction of the "Hydrogen Economy". Hydrogen is potentially the most efficient and environmentally friendly fuel due to its huge energy density and clean combustion, generating water as the only by-product (according to a recent report, the hydrogen based fuel cell market is predicted to grow at a CAGR of 21% to reach $25bn by 2025). However, hydrogen storage is currently one of the key hurdles to hydrogen economy, due to the lack of suitable hydrogen carriers, making most commercial applications unfavorable. The top commercial interest in the field of LOHC are systems that can be simply dehydrogenated and regenerated with considerable hydrogen capacity and thus might be efficiently used for mobility and other key markets. Here we present a promising LOHC system developed by a group of researchers led by Prof. David Milstein. The system is based on inexpensive and readily available group of compounds (piperidines) that can generate hydrogen gas during its conversion to a second group of compounds (pyridines), using a heterogeneous catalyst. The uptake and release of hydrogen is performed at mild conditions (low pressure and temperature) and using a single catalyst, unlike other LOHC systems, and can be repeated with a 100% yield. A hydrogen storage capacity of 5.3 wt% has been demonstrated, that can reach 6.06 wt% with further adjustments.

Applications

Hydrogen-fueled mobility platforms

High-capacity hydrogen storage systems.

Advantages

Heterogeneous catalyst
Liquid to liquid conversion
Solvent free
High hydrogen storage capacity (5.3 wt%, can reach 6.06 wt%)
Relatively mild uptake/release temperature and pressure

00% yield.

echnology's Essence

he technology is based on inexpensive compounds (methylpiperidines and 2,6-dimethylpiperidine) that are atalytically converted to a N-heteroaromatic compound, while forming hydrogen gas, by using a Pd/C eterogeneous catalyst. Efficient hydrogenation can be achieved using the same catalyst, regenerating the riginal compounds. The release of hydrogen is achieved using a catalytic amount of acid reducing the eaction temperature from 300 0C (as previously reported for Pd/C catalysts in similar systems), to as low as 70 0C for hydrogen production and 150 0C for the hydrogenation reaction. The reaction is performed under ery mild pressure conditions (1.6 atm for the hydrogenation reaction and no added pressure for the hydrogen roduction reaction), does not require any solvents and results in 100% yield. The end products are three ydrogen molecules per molecule of carrier and a N-heteroaromatic compound in a liquid form that can be asily regenerated. Repetitive cycles of the dehydrogenation-hydrogenation reactions can be performed ithout adding new catalyst or acid, while maintaining high conversion percentages.

ontact for more information:

aya Gofer, Licensing Officer, +972-8-9344546

ehovot,76100, Israel. Tel: +972-8-947-0617