ORAL B-2

LOHC dehydrogenation catalyst synthesis by ball milling

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Liquid organic hydrogen carriers (LOHCs) provide a promising form of hydrogen storage to enable green hydrogen usage as a carbon neutral energy carrier.[1] The hydrogenation/dehydrogenation reactions of LOHCs are reversible and effective when suitable catalysts are used. However, the dehydrogenation reaction is industrially a new process, and the catalysts are still under development.[2] Supported platinum catalysts are highly active in the dehydrogenation reaction, but they suffer from deactivation.[3] Ball milling (BM) is an emerging solvent-free one-pot synthesis method for supported metal catalysts: High kinetic energies deposit metal particles on catalyst support particles, and in some cases also phase transformations may be facilitated.[4] In this work we synthetized LOHC dehydrogenation catalysts by ball milling and studied the effect of catalyst synthesis method to its properties and performance.

Catalyst BM Pt/TiO_2 was synthetised by ball milling. The jars were filled with platinum and TiO_2 (anatase) powders, sealed, and milled for 3 h at 600 rpm. Catalyst IWI Pt/TiO_2 was synthetised by impregnating Pt to TiO_2 support material via incipient wetness technique. Both catalysts had 1 wt.% Pt loading. Continuous LOHC dehydrogenation experiments were operated in atmospheric pressure in a packed bed quarts glass reactor. The catalyst was activated by reduction. Methylcyclohexane was co-fed with nitrogen, and the reaction took place in vapor state (reactor bed 345−365 °C).

BM synthetized Pt/TiO_2 catalyst had a stable methylcyclohexane (MCH) conversion and 100% selectivity to toluene at 365 °C reactor temperature, whereas its IWI synthetized counterpart deactivated during the 15-hour-experiment. In lower temperature (345 °C) the two catalysts had nearly the same conversion at the end of the experiment.

As a result, a solvent-free, well reproducible, and scalable ball milling method for Pt-based LOHC dehydrogenation catalyst synthesis can be introduced.

References:

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