Catalytic Hydrogen Storage and Delivery Utilizing Formic Acid

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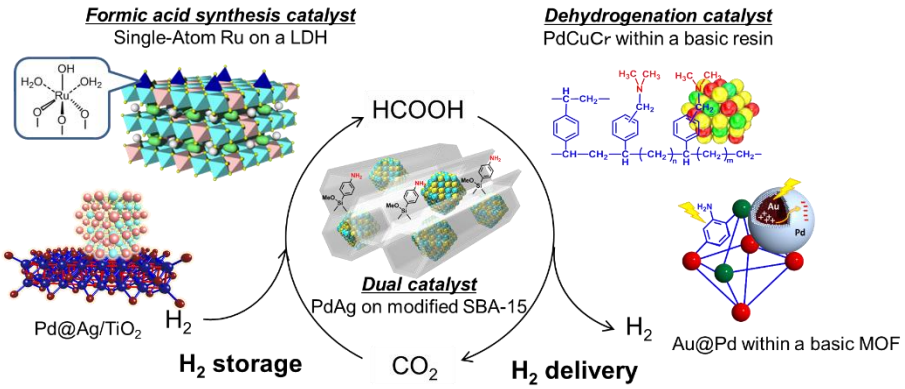
Hydrogen has received increasing attention as a candidate for clean energy, and efficient energy conversion can be realized by combining with fuel cell technology. A considerable amount of research effort is currently devoted to exploring new storage methods.[1] Among investigated, formic acid (HCOOH), which is a liquid at room temperature and contains 4.4 wt% hydrogen, is one of the major products formed during biomass processing and is widely recognized as a convenient hydrogen carrier for fuel cells designed for portable use.[1] Additionally, economical CO_2-mediated hydrogen storage energy cycle can be attained by realizing the regeneration of formic acid through the hydrogenation of CO_2 with H_2.

There have been extensive studies in developing catalysts targeted to either H_2 delivery or H_2 storage mediated by formic acid, independently. Significant progress has been made by using homogeneous catalysts such as Ru and Ir. For the practical reason of on-board application, current research has been focused on the exploitation of efficient heterogeneous catalysts. Bering this in mind, we present herein the heterogeneous nano-catalysts such as PdAg, PdAu, PdCu, PdCuCr, for the efficient production of high-purity H_2 from formic acid dehydrogenation[2-5] and the single-atom Ru catalyst for the hydrogenation of CO_2 to form formic acid.[6] Furthermore, a reversible heterogeneous catalyst has been designed for the interconversion of H_2 and CO_2.[7,8]



Scheme 1. Nano-catalysts for the use of formic acid as a hydrogen energy storage material.

References

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