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Photocatalytic Packed-Bed Flow Reactor for Continuous Room-Temperature Hydrogen Release from Liquid Organic Carriers

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Abstract : Despite the potential of hydrogen (H2) storage in liquid organic carriers to achieve carbon neutrality, the energy required for H2 release and the cost of catalyst recycling has hindered its large-scale adoption. In response, a photo flow reactor packed with rhodium (Rh)/titania (TiO2) photocatalyst was reported for the continuous and selective acceptorless dehydrogenation of 1,2,3,4-tetrahydroquinoline to H2 gas and quinoline under visible light irradiation at room temperature. The tradeoff between the reactor pressure drop and its photocatalytic surface area was resolved by selective in-situ photodeposition of Rh in the photo flow reactor post-packing on the outer surface of the TiO2 microparticles available to photon flux, thereby reducing the optimal Rh loading by 10 times compared to a batch reactor, while facilitating catalyst reuse and regeneration. An example of using quinoline as a hydrogen acceptor to lower the energy of the hydrogen production step was demonstrated via the water-gas shift reaction.

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