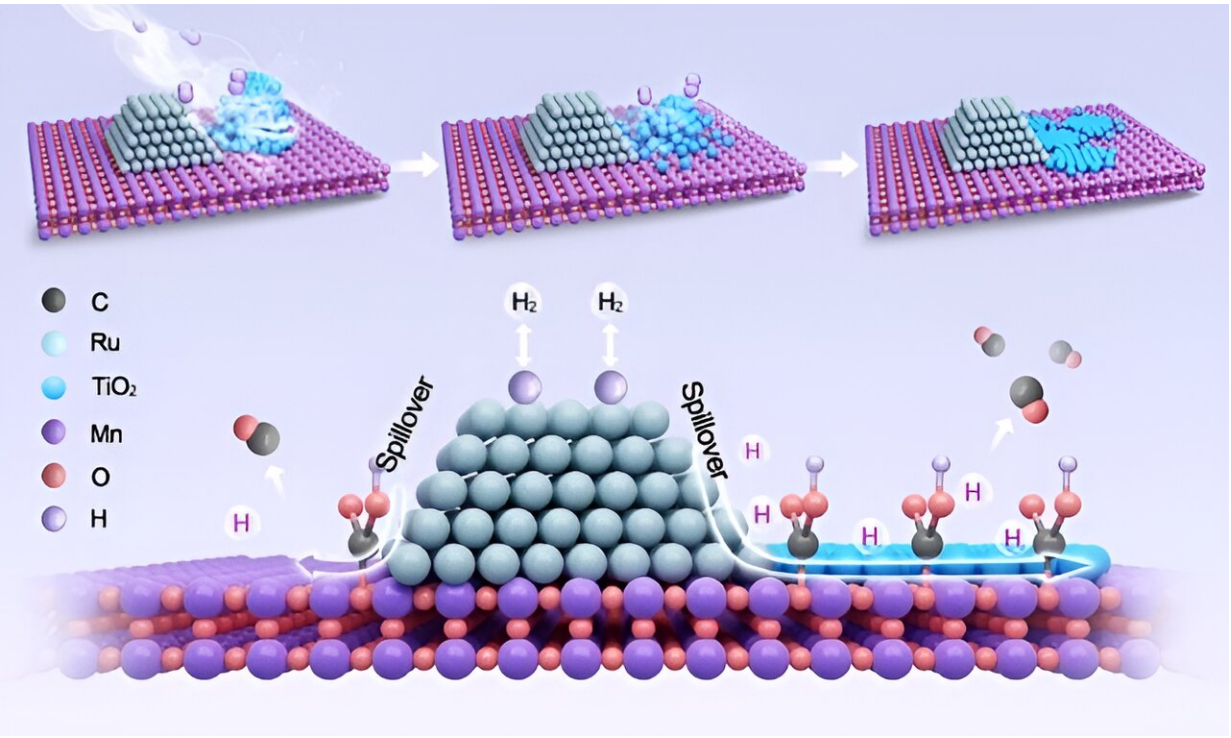
New migration strategy to boost CO2 reduction to CO

October 24 2023, by Li Yuan



In-situ generation of highly efficient H-transport channel for CO2 reduction to CO. Credit: Kang Hui

Classical strong metal–support interaction (SMSI) theory describes the way reducible oxide migrates to the surface of metal nanoparticles (NPs) to obtain metal@oxide encapsulation structure during high-temperature H_2 thermal treatment, resulting in high selectivity and stability.

However, the encapsulation structure inhibits the adsorption and dissociation of reactant molecules (e.g., H_2) over metal, leading to low activity, especially for the hydrogenation reaction.

Recently, a research group led by Prof. Liu Yuefeng from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) has proposed a new migration strategy, in which the TiO_2 selectively migrates to second oxide support rather than the surface of metal NPs in Ru/(TiO_x)MnO catalysts, boosting the CO_2 reduction to CO via a reverse water–gas shift reaction.

The study was published in *Nature Catalysis* on Oct. 9.

The researchers achieved controlled migration by utilizing the strong interaction between TiO_2 and MnO in Ru/(TiO_x)MnO catalysts during H_2 thermal treatment, and TiO_2 spontaneously re-dispersed on the MnO surface, avoiding the formation of TiO_x shell on Ru NPs for the ternary catalyst (Ru/TiO_x/MnO).

Meanwhile, high-density TiO_x/MnO interfaces generated during the process and acted as a highly efficient H transportation channel with low barrier, and resulting in enhanced H-spillover for the migration of activated H species from metal Ru to support for consequent reaction.

The Ru/TiO_x/MnO catalyst showed 3.3-fold catalytic activity for CO_2 reduction to CO compared with a Ru/MnO catalyst. In addition, the Ti/Mn support preparation was not sensitive to the crystalline structure and grain size of TiO_2 NPs. Even the mechanical mixing of Ru/TiO_2 and Ru/MnO_x enhanced the activity.

Moreover, the researchers verified that the synergistic effect of TiO_2 and MnO didn't alter the catalytic intrinsic performance, and efficient H transport provided a large number of active sites (hydroxyl groups) for

the reaction process.

"Our study provides references for the design of novel selective hydrogenation catalysts via the in-situ creation of oxide–oxide interfaces acting as hydrogen species transport channels," said Prof. Liu.

More information: Hui Kang et al, Generation of oxide surface patches promoting H-spillover in Ru/(TiOx)MnO catalysts enables CO2 reduction to CO, *Nature Catalysis* (2023). DOI: 10.1038/s41929-023-01040-0

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