# Research reveals gas-phase migration route for formation of strong metal-support interaction state

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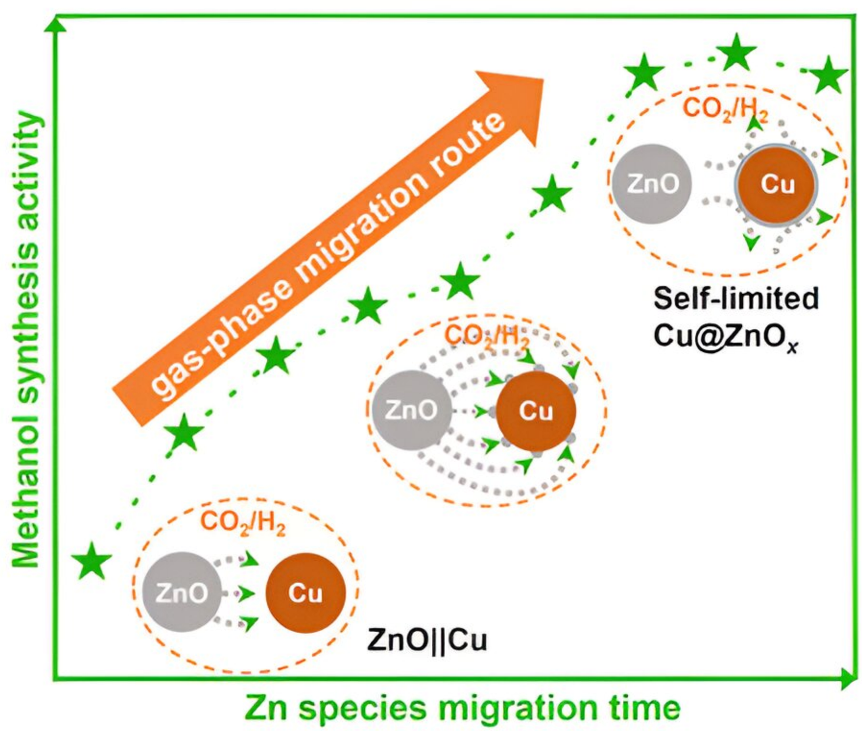


Schematic illustration of the formation of self-limited Cu@ZnOx structure via gas-phase migration route and its effect on CO2 hydrogenation to methanol over Cu/Al2O3 catalysts. Credit: Song Tongyuan, from *Angewandte Chemie International Edition* (2023). DOI: 10.1002/anie.202316888

Strong metal-support interaction (SMSI) is one of the most important concepts in heterogeneous catalysis. Triggered by pretreatment or reaction processes, the supported metal nanoparticles may be partially or completely encapsulated by support-derived overlayers, which impact the catalytic performance of supported metal catalysts. However, the formation mechanism of the SMSI state is still unclear.

Recently, a research team led by Prof. Fu Qiang from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) proposed a gas-phase migration route for the formation of SMSI. This work was published in *Angewandte Chemie International Edition*.

So far, two diffusion routes of the support-derived species onto the metal surface have been suggested, including interface alloying and surface migration.

In this work, the researchers placed ZnO particles and Cu/$Al_2O_3$ powders in a microreactor in a dual-bed mode (ZnO||Cu/$Al_2O_3$). By utilizing gas-phase migration of Zn species in $CO_2/H_2$ atmosphere (0.5% $CO_2/H_2$, 450°C), they found that a self-limited thin $ZnO_x$ overlayer grew on the surface of Cu nanoparticles (Cu@$ZnO_x$) in the Cu/$Al_2O_3$ catalyst without excessive deposition and aggregation of $ZnO_x$ species. Thus, they obtained an optimal number of $ZnO_x$-Cu interface sites, which enhanced the methanol synthesis activity.

Moreover, the researchers demonstrated that the formation of the self-limited Cu@$ZnO_x$ encapsulation structure was due to the evaporation of Zn atoms from the ZnO particles, migration to the Cu/$Al_2O_3$ catalyst, and further deposition onto the Cu surface to form $ZnO_x$ overlayers under the synergistic effect of reducing $H_2$ and oxidizing $CO_2$ components at the treatment temperature.

"Our work elucidates the high temperature redox atmosphere-induced gas-phase migration route to the formation of the encapsulation structure or the classic SMSI state," said Prof. Fu.

**More information:** Tongyuan Song et al, Enhanced Methanol Synthesis over Self-Limited ZnOx Overlayers on Cu Nanoparticles Formed via Gas-Phase Migration Route, *Angewandte Chemie International Edition* (2023). DOI: 10.1002/anie.202316888

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