Understanding the effect of Sm_2O_3 and CeO_2 promoters on the structure and activity of Rh/Al_2O_3 catalysts in methane steam reforming

The methane steam reforming (MSR) reaction is a major source of H_2. It also produces syngas, a mixture of CO and H_2, which can be converted into higher value chemicals. Rh is one of the most active metals and doping of the Al_2O_3 support by CeO_2 is widely employed to boost the activity and stability of the catalysts. CeO_2 has a high oxygen storage capacity (OSC) and its chemical interaction with noble metals stabilizes the nano-sized particles.

Catalytic MSR was performed in a CATLAB instrument from Hiden Analytical equipped with a plug-flow reactor and an integrated mass spectrometer. With this system we were able to pre-treat the samples and record the amount of reactants and products at the reactor exit during MSR to measure the reaction rates and test the stability of the catalysts.

The catalysts were studied by means of multiple techniques to understand the role played by CeO_2 with regard to the structure of the active phase and the cause of deactivation of active and selective catalysts. Promoted catalysts showed higher reaction rates per surface Rh atom and improved stability compared to Rh/Al_2O_3. *In situ* X-ray absorption revealed that the structure of Rh particles in Rh/Al_2O_3 changes drastically during MSR, while it was stable in the presence of CeO_2. Sintering of the active metal phase was the main cause of deactivation. Electron microscopy images showed that there was enhanced sintering in the Rh/Al_2O_3 catalyst and, therefore, stronger deactivation during reaction. At 773 K, the particles re-dispersed and the sintering occurred at 1033 K. The Al_2O_3-supported catalyst showed a small amount of oxidic Rh, which may have contributed to its lower reaction rate. The increase in the stability of the promoted catalyst is due to the strong interaction of Rh and the support, which inhibited particle re-dispersion, Rh oxidation and sintering, thus maintaining high dispersion during the reaction.

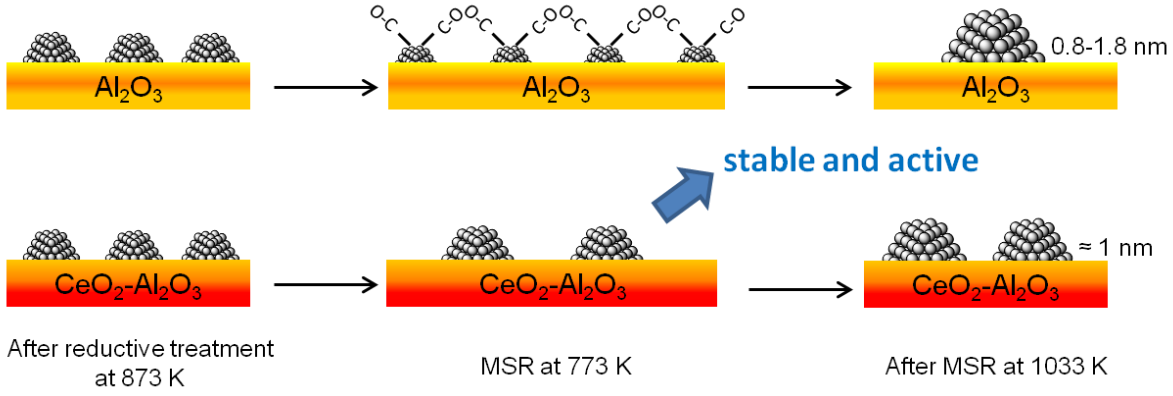

Fig 1: Proposed scheme for the re-dispersion and sintering of the Rh particles during different steps based on the EXAFS and electron microscopy results.

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Hiden Product: CATLAB Microreactor with Integrated MS

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Hiden Product:
CATLAB Microreactor with integrated Mass Spectrometer

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