Inorganic Materials & catalysis

Research Project – Emiel Hensen/Liang Liu

IMC
INORGANIC MATERIALS & CATALYSIS

Preparation of Dispersed Oxide by Flame Spray Pyrolysis Method for CO_2 Hydrogenation to methanol

Carbon dioxide (CO_2) as the one of the greenhouse gases has a negative impact on climate change and ocean acidification. The chemical transformation of CO_2 to high calorific fuels is particularly attractive. A series of metal (Cu, Pt, Pd, Ni) supported on oxide surface has been detected its catalytic performance in CO_2 hydrogenation. The interface between metal and dispersed oxide and the size of active phase are crucial to control methanol selectivity. It is reported that Pd supported on TiO_2 displayed the highest activity for CO_2 hydrogenation among Pd supported on Al_2O_3, SiO_2, TiO_2, and MgO. The selectivity of CO_2 hydrogenation on Pd/oxides catalysts was shown to largely depend on Pd particle size. CO and CH_3OH were produced on poorly dispersed Pd, while CH_4 was the main product on highly dispersed Pd[1]. While in Pd/In_2O_3 system, a controlled co-precipitation method has been developed to replace the indium atoms in the active In_3O_5 with the palladium atoms, which facilitates H_2 activation and further to enhance the methanol product selectivity [2]. Thus, how to construct the active interface and efficient particle size is a challenge.

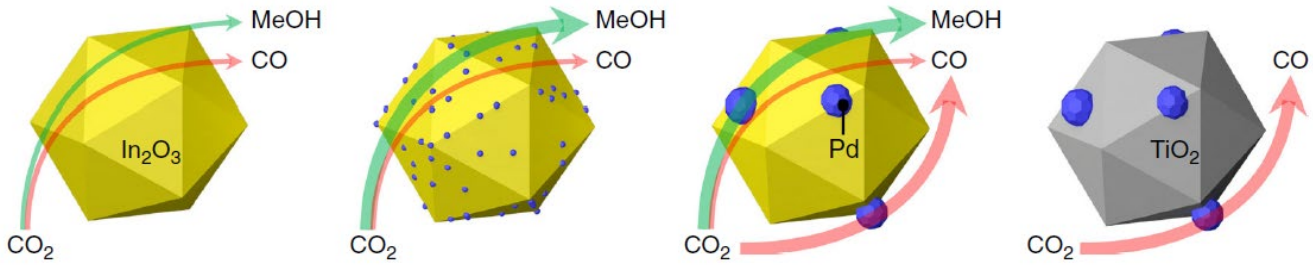

Figure 1. Schematic representation of the distinct role of palladium in equilibrated CP and DI systems with In_2O_3 and Pd-TiO_2 as references [2]

In this project, we would like to work in the direction of flame spray pyrolysis as a technique to develop highly dispersed oxides with transition metal (like Fe, Co, Ni, Cu, Pd, Pt) doped into them as model systems for CO_2 hydrogenation. All kinds of characterizations like FTIR, Raman, TPR, XPS (including NAP XPS) and EXAFS/XANES may be required, so as to detect the size effect of oxides on CO_2 hydrogenation reaction. The size effect and the interface function will be able to investigate in detail the reactions occurring at the catalytic surface, contributing to the development of better catalytic processes for renewable energy storage.

Possible projects

1. Develop and understand the size effect of active sites prepared by flame spray pyrolysis method for CO_2 hydrogenation to methanol.

2. Construct the active interface between transition metal and dispersed oxide to improve the catalytic performance.

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References:

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[2] Frei M S, Mondelli C, García-Muelas R, et al. *Nat Commun* **2019**, 10(1): 1-11