XAS characterization for the interaction between gold and the support

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Introduction

Catalysis by gold has been attracted intensive attention since the pioneering work reported in the 1980's. It has been turned out that the control of the size of gold is one of the most important issues for gold catalysis. In the last decade, we've developed several methods to control the particle size of gold, for example, adding a second metal to form alloy with gold, using the thiolated gold nanoclusters as the precursor of gold catalysts, and so on. Why the gold could be stabilized by the above method? This question is not easy to be answered due to the difficulty in characterization. X ray absorption spectroscopy (XAS) is a powerful tool to get the chemical environment of gold including the valence state and the number and distance of the coordination atoms. We deliberately designed *in situ* reactors to explore the structural evolution of the catalysts during pretreatment and reaction processes by the XAS.

Experimental methods

The in situ cell was designed as a quartz tube similar to the device for performing gas-solid catalytic reaction, for example, CO oxidation reaction. The XAS experiments were done at beam line 17C1 at the National Synchrotron Radiation Center (Taiwan) and beam line 14W at the Shanghai Synchrotron Radiation Facility. The data were collected by the transmission or fluorescence mode depending on the nature of the support and the loading of gold.

Results and discussion

The results turned out that the size control of gold for the methods we developed previously can all be ascribed to the tuning of the metal-support interaction. For example, as evidenced by the *in situ* XAS results, the second metal in the gold-based bimetallic catalyst formed MOx (M: the second metal that was added to form bimetallic nanoparticles with gold, *e.g.*, Cu, Ag, Rh, Pd, *etc.*) at the interfaces between the metal and the support and acted as "nanoglue" anchoring the bimetallic nanoparticle nanopartilces on the inert support (*e.g.*, SiO_2, Al_2O_3, *etc.*). Besides, the XAS results also manifested that the residual sulfur in the thiolated Au_{25} nanocluster could form Au-S-M (M: metal ions from the support, *e.g.*, Zn, Ni, Mg, *etc.*) bond and stabilize gold while using the thiolated Au_{25} nanoclusters as the precursor of gold.

Conclusion

By characterization with XAS, the interaction between gold and the support could be clearly pictured and the intrinsic origin of the high stability of the supported gold nanoparticles could be well understood. These results could provide good references to the design of gold catalysts with controllable size.

References

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Acknowledgement

National Natural Science Foundation of China (21522608, 21476227 and 21776271)