

Mechanism of organic chemical reactions on nano-porous gold

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Recently, the catalytic activities of nano-porous (several tens nm) gold for gas phase reactions such as CO or methanol oxidations have been found by several groups [1-3]. The activity of the nano-porous gold is characteristic and is not observed on other catalysts. For example, gold is a chemically stable metal in the bulk form, however, by the formation of nano-porous structure, gold show high catalytic activity for CO or methanol oxidation [1-3]. Although the nano-particle (2-3 nm) of gold also show the catalytic activities, usually supporting materials (metal oxides or carbon materials) which modify the geometric/electronic structure of the gold is necessary to observe the catalytic activity [4-6]. The nano-porous gold show the catalytic activity without supporting materials. Therefore, the elucidation of the reaction mechanism on nano-porous gold catalysts is important to develop new catalysts. We have found that the nano-porous gold show new catalytic activity for organic reactions in liquid phases [7-8]. However, the reaction mechanism is still unclear. To develop new catalysts, we have studied the reaction mechanism of the organic reaction by using surface science techniques (photo-electron spectroscopy and thermal desorption spectroscopy). Based on the observation of surface structure, electronic structure and adsorption structure, we will discuss the mechanism to produce the characteristic reactivity on nano-porous gold.

[1] V. Zielasek, B. Jurgens, C. Schulz, J. Biener, M. M. Biener, A. V. Hamza, M. Baumer, *Angew. Chem.* 118, 8421-8425 (2006).

[2] C. Xu, J. Su, X. Xu, P. Liu, H. Zhao, F. Tian, Y. Ding, *J. Am. Chem. Soc.*, 129, 42-43 (2007).

[3] A. Wittstock, V. Zielasek, J. Biener, C. M. Friend, M. Baumer, *Science*, 327, 319-322 (2010).

[4] M. Haruta, S. Tsubota, T. Kobayashi, H. Kageyama, M.J. Genet and B. Delmon, *J. Catal.* 144, 175 (1993).

[5] M. Haruta, *Gold Bull.* 37, 27 (2004).

[6] T. Minato, T. Susaki, S. Shiraki, H.S. Kato, M. Kawai, and K.-I. Aika: *Surf. Sci.* 566, 1012 (2004).

[7] N. Asao, Y. Ishikawa, N. Hatakeyama, Menggenbateer, Y. Yamamoto, M.

Chen, W. Zhang, A. Inoue, *Angew. Chem.*, 122, 10291- 10293 (2010).

[8] N. Asao, Y. Ishikawa, N. Hatakeyama, Menggenbateer, Y. Yamamoto, M. Chen, W. Zhang, A. Inoue, *Angew. Chem. Int. Ed.*, 49, 10093-10095 (2010).