A2-12 Mechanism of Heterogeneous Catalysis Clarified by Surface Science Technique

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Heterogeneous catalysts are pivotal materials in chemical industry. However, the mechanism of catalytic reactions taking place on solid surfaces is very complex. Direct observation of catalyst surface by surface-science technique is needed to clarify the mechanism of catalytic reactions and the active catalytic sites. The most important point in the surface science approach is to establish a model catalyst with well-defined structures, in which the catalytic sites must be identical to those of industrial catalysts. In my presentation, model catalyst studies will be introduced concerning methanol synthesis from CO_2 and nitrogen-doped carbon catalysts for fuel cells. In the first topic, I will be talking about CuZn active sites of Cu/ZnO catalysts for the methanol synthesis from CO_2, which has been a controversial issue[1]. A unique Eley-Rideal typed mechanism of CO_2 with adsorbed hydrogen on Cu surfaces will be also introduced[2], which has been accidentally discovered during the methanol synthesis study. In the second topics, I will introduce the model study of nitrogen doped carbon catalysts that clarifies which nitrogen, graphitic nitrogen or pyridinic nitrogen creates the active site of oxygen reduction reaction (ORR)[3].

Fig.1 Reaction takes place by supplying vibrational energy only to CO_2 without heating a Cu catalyst. *Nature Chemistry* (ref.2)

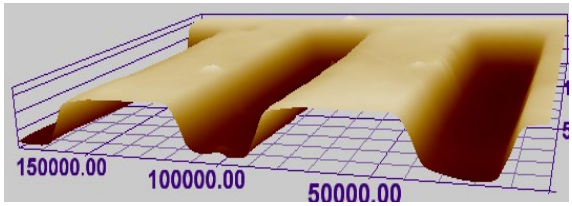

Fig.2 Active sites of nitrogen-doped carbon catalysts are created by pyridinic nitrogen which has been clarified by graphite model catalysts. *Science* (ref.3)

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2) J. Quan, F. Muttaqien, T. Kondo, T. Kozarashi, T. Mogi, T. Imabayashi, Y. Hamamoto, K. Inagaki, I. Hamada, Y. Morikawa, J. Nakamura, *Nature Chem.* **2019**, *11*,722.
3) D. Guo, R. Shibuya, C. Akiba, S. Saji, T. Kondo, J. Nakamura, *Science* **2016**, *351*, 361.

PROFILE

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[1] Ph.D degree from Hokkaido University (1988), Posdoc in Indiana Univ and Univ of Washington (1988-1990), Lecturer, Associate Professor, and Professor in University of Tsukuba (1990-April 2022) [2] Catalytic chemistry and surface science, [3] Award of Catalysis Society of Japan (for young researcher) (1993), Surface Science Society Award (2017), The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology Ministry of Education (2018), Catalysis Society of Japan Award (Academic field) (2018), [4] ref.3 is the top citation among original papers with a keyword of "catalyst" published since 2016, [5] nakamura.junji.700@m.kyushu-u.ac.jp