New Concepts of Confined Catalysis and Catalytic Conversion of Energy Molecules

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Catalysis, as a key and enabling technology, plays an increasingly important role in fields ranging from energy, environment and agriculture to health care. Rational design and synthesis of highly efficient catalysts has become the ultimate goal of catalysis research. Thanks to the rapid development of nanoscience and nanotechnology, and in particular a theoretical understanding of the tuning of electronic structure in nanoscale systems, this element of design is becoming possible via precise control of nanoparticles' composition, morphology, structure and electronic states. In this talk, I will discuss nano-confinement effects in catalysis, a concept that we have put forward and developed over a decade, and the emphasis will be laid on the development of the novel nano-materials as catalysts for energy processes. Taking the confined catalytic systems of carbon nanotubes (CNTs), metal-confined nano-oxides, two dimensional (2D) layered nano-catalysts and nano composite as the examples, we summarize and analyze the fundamental concepts, the research methods and some of the key scientific issues involved in nanocatalysis. The important applications of such materials in catalytic conversion of methane and syngas to valuable chemicals will be introduced, as the examples. The concept of "catalysis by nanoconfinement" developed from the theoretical and experimental research in several catalytic systems has found generality in catalysis and is widely accepted as "new catalytic concept". This concept provides guidance for re-directing catalysis from crafts to sciences.

References

[1] Q Fu, W Li, Y Yao, H Liu, H Su, D Ma, X Gu, L Chen, Z Wang, H Zhang, B Wang and X Bao*, *Science*, 328 (2010)1141-11442;
[2] X Pan, X Bao*, *Acc. Chem. Res.*, 44 (2011) 553-562;
[3] Q Fu*, F Yang, X Bao*, *Acc. Chem. Res.*, 46 (2013) 1692-1701;
[4] X Guo, G Fang, G Li, H Ma, H Fan, L Yu, C Ma, X Wu, D Deng, M Wei, D Tan, R Si, S Zhang, Ji Li, L Sun, Z Tang, X Pan and X Bao*, *Science*, 344 (2014) 616-619;
[5] F. Jiao, J Li, X Pan, X Bao*, et al., *Science*, 351 (2016) 1065-1068;
[6] Q Fu*, X Bao, *Chem. Soc. Rev.*, 46 (2017) 1842-1874;
[7] P Schwach, X Pan,* and X Bao*, *Chem. Rev.*, 117 (2017) 8497−8520
[8] Y Liu, F Yang*, Y Zhang, J Xiao, L Yu, Q Liu, Y Ning, Z Zhou, H Chen, W Huang, P Liu, X Bao*, *Nat. Commu.* (2017) 14459;
[9] F Jiao, X Pan*, K Gong, and X Bao*, et al., *Angew. Chem. Int. Ed.*, 57 (2018) 4692−4696;