Heterogeneous catalysis under confinement via rational ship-in-a-bottle synthesis

With the support by the National Natural Science Foundation of China, the Ministry of Science and Technology of China, and the Chinese Academy of Sciences, the research team led by Prof. Fu Qiang (傅强) and Prof. Bao XinHe (包信和) at the State Key Laboratory of Catalysis, Dalian Institute of Chemical Physics, Chinese Academy of Sciences reported a metal-organic framework (MOF) confined RuO_2 catalyst (RuO_2 @ MOF-808-P) with exceptionally high catalytic CO oxidation below 150℃. The article was published in *Nature Communications* (2019, 10: 1340).

When materials are confined inside pores with typical dimension of 1-to-2 nm of host materials, they behave differently from their bulk form. This is known as confinement effect. In the case of heterogeneous catalysis, confinement may keep nanocatalysts well separated, preserve their highly reactive surface, and lead to higher catalytic activity. Loading a guest material inside the nano-pore of a host can, however, be very challenging since the loading is severely limited by the pore opening size and stability of the host. In collaboration with the University of Cambridge, Queen Mary University of London, National University of Singapore, and University of New South Wales, the scientists have introduced a novel and general concept to place guests inside the pores of nanoporous materials. They term the relevant approach as Pourbaix-Enabled Guest Synthesis (PEGS), as they apply the pre-established electrochemical potential versus pH phase diagrams (a. k. a. Pourbaix diagrams) to rationally select reaction agents and conditions for guest formation. The PEGS strategy not only facilitates the study of confinement effect but also opens up the possibility of multifunctional host-guest nanocomposites with either different functions from host and guest or novel properties due to the host-guest interactions.

By using this PEGS route, the team successfully placed RuO_2 inside the nano-cavity of MOF-808-P with controlled loading. Compared to the conventional RuO_2-based catalyst supported on a SiO_2 surface, they found that CO adsorption on RuO_2 confined inside MOF's pores can be significantly weakened. Such discovery provides the basis for improved catalysis from preventing low-temperature CO poisoning, which was demonstrated with the highly active RuO_2@MOF-808-P for CO oxidation at low temperatures.

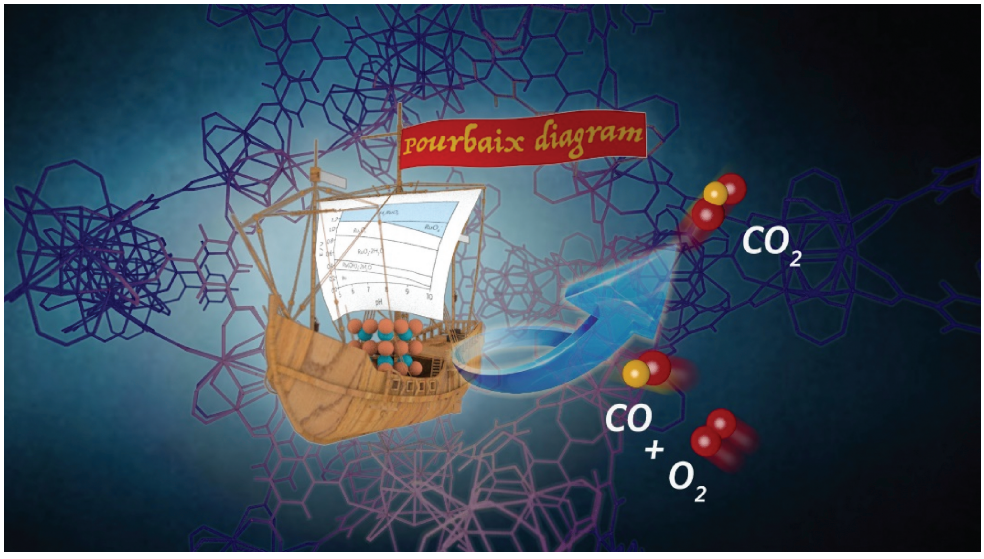

Figure Using Pourbaix-Enabled Guest Synthesis (PEGS), researchers can place RuO_2 inside nano-sized pores of a metal-organic framework (MOF) like a ship in a bottle for superior CO oxidation catalysis.