CO preferential oxidation over ordered mesoporous Co_3O_4-based composite catalysts

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Preferential oxidation of carbon monoxide (CO-PROX) has got a great attention during decades, especially in proton exchange membrane fuel cell (PEMFC) field due to its simplicity and cost-effectiveness for the removal of CO in the H_2 fuel. This is because CO gas in the H_2 fuel contaminates Pt electrodes in PEMFC system, thus the performance of PEMFC diminished. [1,2]

Among various kinds of materials, noble metals (Pt, Rh, Ru, and Au) were recognized as the promising candidates for effective CO-PROX reaction, however noble metal catalysts were not attractive due to their high costs.

Transition metal oxides (Co_3O_4, MnO_2, etc.) have been investigated for escaping from noble metal catalysis system. Co_3O_4 is a well-known CO-PROX catalyst which exhibits high catalytic performance (CO oxidation by O_2) at low temperature. In the preliminary research, ordered mesoporous Co_3O_4 showed high catalytic performances with T_{50} of 68 °C due to its high surface area (that is, large active sites on the catalyst). [3]

In this work, we enhanced the CO-PROX performance of ordered mesoporous Co_3O_4 using 2 strategies: Co metal incorporation with ordered mesoporous Co_3O_4 framework and other transition metal doping. There were the studies of Co metal promotion in noble metal catalysts for improving CO-PROX activity. [4–6] Also, other transition metal additives (such as Cu, Fe, etc.) in Co_3O_4 framework enhanced on the catalytic activity of ordered mesoporous Co_3O_4 due to the change of surface electronic structures. [7]

Thus, we prepared ordered mesoporous CoO, Co_3O_4, Co/Co_3O_4, and transition metal (Cu, Fe, etc.) and Co_3O_4 nanocomposites for CO-PROX by nano-casting method using KIT-6 silica hard template. The physicochemical properties of prepared catalysts were evaluated with X-ray diffraction (XRD), N_2 adsorption-desorption analysis, electron microscopy (SEM and TEM) with energy-dispersive X-ray spectroscopy (EDX), and temperature programmed experiments (TPR and TPD). The CO-PROX activity was improved when Co metal was incorporated with Co_3O_4 framework.

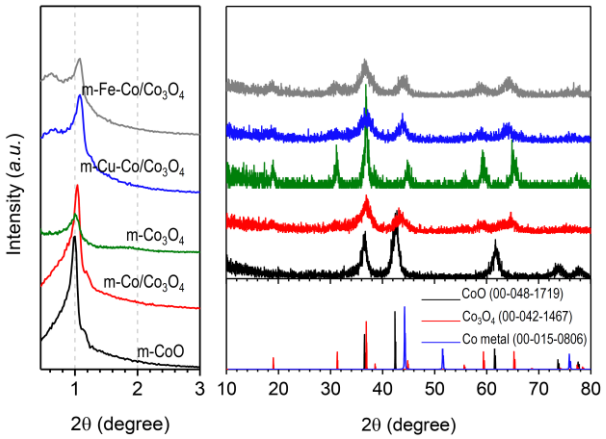

Fig.1 XRD patterns of prepared materials.

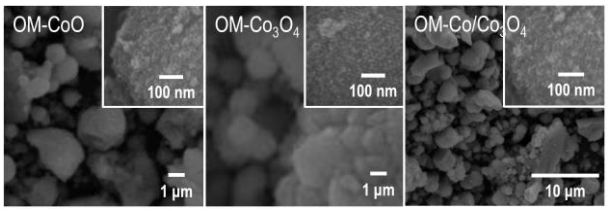

Fig.2 SEM with HR-SEM (in-set images) of prepared materials.

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