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Binary Metal Oxide Catalysts for Low-Temperature Catalytic Oxidation of HCHO in Air

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Abstract : It is well known that many oxidation reactions in nature are closely related to the origin and life activities. One of the features of these natural reactions is that they can proceed under mild conditions employing the oxidant of molecular oxygen (O_2) in the air and enzymes as catalysts. Catalysis is also a necessary part of life for human beings, as many chemical and pharmaceutical industrial processes need to use catalysts. However, most heterogeneous catalytic reactions must be run at high operational reaction temperatures and pressures. It is not strange that, in recent years, research interest has been redirected to green catalysis, e.g., trying to run catalytic reactions under relatively mild conditions as much as possible, which needs to employ green solvents, green oxidants such O_2, particularly air, and novel catalysts. This work reports the efficient binary Fe-Mn metal oxide catalysts for low-temperature formaldehyde (HCHO) oxidation, a toxic pollutant in the air, particularly in indoor environments. We prepared a series of nanosized FeMn oxide catalysts and found that when the molar ratio of Fe/Mn = 1:1, the catalyst exhibited the highest catalytic activity. At room temperature, we realized the complete oxidation of HCHO on this catalyst for 20 h with a high GHSV of 150 L g^{-1} h^{-1}. After a systematic investigation of the catalyst structure and the reaction, we identified the reaction intermediates, including dioxymethylene, formate, carbonate, etc. It is found that the oxygen vacancies and the derived active oxygen species contributed to this high-low-temperature catalytic activity. These findings deepen the understanding of the catalysis of these binary Fe-Mn metal oxide catalysts.

Keywords : oxygen vacancy, catalytic oxidation, binary transition oxide, formaldehyde
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