Optimal Pd:Pt ratio of alumina supported catalysts for methane oxidation

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Natural gas started to be used actively after the shale revolution. The emission control of CH_4 is a challengeable issue due to the high sensitivity to the O_2 concentration and strong C-H bond of CH_4. Here we examined seven alumina-supported catalysts as a function of the Pd:Pt ratio (molar basis of 1:0, 9:1, 3:1, 1:1, 1:3, 1:9 and 0:1). The purpose of this study comprises mainly two issues of methane oxidation: (i) water vapor inhibition and (ii) reaction environment (variable O_2 concentrations) on the catalytic performance with a special focus on the Pd:Pt ratio. In combination with various characterization tools such as HAADF-STEM, H_2-TPR and XPS, the reactor data have identified the role of Pt doping on Pd crystallites and an optimal ratio of Pd:Pt in the CH_4 oxidations under a wide range of reaction environments. The numerical DFT calculation supported our observations by providing intrinsic chemistry of Pd:Pt catalytic reaction: (i) strength of the CH_4 binding and on metal surfaces and (ii) O_2 adsorption and its dissociation energy barrier.