Ambient Pressure X-ray Photoelectron Spectroscopy Study of Photoreduction of CO2 with H2O on Pt-loaded TiO2(110)

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Abstract

Since the industrial revolution, the excessive consumption of fossil fuels by human activities has caused a large amount of greenhouse gas and pollutant emissions. The concentration of CO_2 in the atmosphere is higher and higher, causing recovery and reuse of the carbon dioxide becomes a substantial issue. TiO_2 is a good material for the photocatalytic reactions of CO_2. The addition of a metal acts as a co-catalyst can increase its catalytic activity. In this study, we mainly use the ambient pressure x-ray photoelectron spectroscopy (APXPS) to investigate the mechanism of photocatalytic reduction of carbon dioxide by water on TiO_2(110) and Pt/TiO_2(110) surface. Pt/TiO_2(110) photocatalysts were prepared by physical vapor deposition (PVD) on the TiO_2(110) and characterized by means of the x-ray photoelectron spectroscopy (XPS) to confirm the loading concentration of Pt. Here, we used the APXPS to identify the intermediates in the photocatalytic reaction and combined with the temperature programmed reaction spectroscopy (TPRS) to examine the surface species desorbed from the surface after the photocatalytic reaction. In XPS data, we can observe the formation of formate (HCO_2^-) and methoxy (OCH_3) species which are an important intermediate toward CH_4 and CH_3OH under UV light. The photocatalytic reduction products such as CH_4, CO and CH_3OH were also observed in the TPRS. The experimental results show that the Pt loading can greatly enhance the performance of photocatalytic reduction of CO_2. Compared with the bare TiO_2, the Pt/TiO_2(110) sample has more growing carbon content on the surface when irradiated with UV light.

Keywords –TiO_2, co-catalyst, APXP