TRS FT-IR Spectroscopy of Surface Intermediates of C_2H_4 Hydrogenation over Pt/Al_2O_3 Catalyst under Reaction Conditions

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Time-resolved rapid-scan FT-IR spectra of ethylene hydrogenation over alumina-supported Pt catalyst at 200°C were recorded under continuous H_2/N_2 flow and pulsed release of C_2H_4 (30 millisecond duration). Two surface species were observed, namely ethylidyne (CH_3CPt_3) with peaks at 2880 and 1339 cm^{-1} (lifetime 300 ± 50 msec), and a substantially shorter-lived intermediate with an intense band at 1200 cm^{-1} and weak absorptions in the 2875-2860 cm-1 region (lifetime around 100 msec). Comparison of the C_2H_4 + H_2 results with those of experiments using D_2 or C_2D_4 suggests that the 1200 cm^{-1} species is a surface ethyl intermediate (CH_3CH_2Pt). This is the first observation on the lifetime of surface ethyl species under reaction conditions. The rise of the final ethane product, monitored by the ν(CH) absorption at 2893 cm^{-1} was found to reach a maximum already in the first recorded time slice. This suggests that the observed CH_3CH_2Pt species is a surface-trapped form of the kinetically relevant, only weakly interacting C_2H_5 radical intermediate.