Correlation between Acidic Properties of Nickel Sulfate Supported on TiO_2-ZrO_2 and Catalytic Activity for Ethylene Dimerization

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A series of catalysts, $NiSO_4/TiO_2$-ZrO_2, for ethylene dimerization was prepared by the impregnation method using an aqueous solution of nickel sulfate. Calcination at 300-600 ℃ of coprecipitated Ti $(OH)_4$-$Zr(OH)_4$ resulted in the formation of an amorphous phase and further heating at 700 ℃ and above resulted in the formation of crystalline $ZrTiO_4$ compound. The addition of nickel sulfate to TiO_2-ZrO_2 shifted the phase transition of $TiZrO_4$ from amorphous to orthorhombic to higher temperature because of the interaction between nickel sulfate and $TiZrO_4$, and the specific surface area and acid amount of $NiSO_4/TiO_2$-ZrO_2 increased in proportion to the nickel sulfate content up to 10-20 wt% of $NiSO_4$. Nickel sulfate supported on TiO_2-ZrO_2 was found to be very active even at room temperature, giving a maximum in both activity and acidity when catalyst containing 20 % $NiSO_4$ was calcined and evacuated at 500 ℃. The high catalytic activity of $NiSO_4/TiO_2$-ZrO_2 was related to the increase of acidity and acid strength due to the addition of $NiSO_4$. The asymmetric stretching frequency of the S=O bonds for $NiSO_4/TiO_2$-ZrO_2 samples was related to the acidic properties and catalytic activity.