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Effect of Mo:V ratio on surface phase composition and catalytic characteristics of V_2O_5-MoO_3/Al_2O_3 catalysts for oxidative dehydrogenation of propane

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Supported vanadia composites are known as promising catalysts for oxidative dehydrogenation (ODH) of light alkanes including propane. A high catalytic performance of such catalysts is caursed by the distribution of vanadium over the support surface in the form of 2D vanadia species. However, a low selectivity due to propylene overoxidation remains a challenge. Modification of vanadia catalysts with oxides of various metals (such as Mg, Mo, etc.) was shown to contribute to the increase of selectivity towards the target product.[1-2] At the same time, the optimal composition and structure of the active species in the multicomponent systems as well as their relationship with the catalytic properties remains unclear. In our previous work, the features of the formation of active species in the supported monolayer V_2O_5–MoO_3/Al_2O_3 catalysts for ODH of propane depending on the preparation approach were studied, with the consecutive impregnation of alumina support firstly with the solution of vanadium precursor and secondly with the solution of molybdenum precursor being the most advantageous. The present work is focused on the study of the effect of the active components ratio in the monolayer V_2O_5-MoO_3/Al_2O_3 catalysts on their catalytic properties towards propane ODH.

A series of V_2O_5-MoO_3/Al_2O_3 catalysts with a total V + Mo content corresponding to the monolayer surface coverage and different V : Mo ratio were prepared by the consecutive support impregnation of alumina support firstly with the solution of vanadium precursor and secondly with the solution of molybdenum precursor. Ammonium metavanadate NH_4VO_3 and ammonium heptamolybdate $(NH_4)_6Mo_7O_{24}$ were used as starting compounds of the supported components. To increase the solubility of NH_4VO_3 and $(NH_4)_6Mo_7O_{24}$, oxalic and citric acids were used, respectively. The vanadium content in the V_2O_5-MoO_3/Al_2O_3 catalysts prepared was 0.15, 0.3, 0.5, and 1 monolayer. The intermediate V_2O_5/Al_2O_3 and V_2O_5-MoO_3/Al_2O_3 target samples were calcined at 500 ºC. A complex of methods including low-temperature nitrogen adsorption, UV-vis DR and Raman spectroscopy was used to study the textural characteristics, phase composition and structural characteristics of the obtained samples. The catalytic properties of the samples were studied in the reaction of oxidative dehydrogenation of propane.

According to UV-vis DR and Raman spectroscopy, the supported components are present in samples in the form of surface oligomeric or polymeric VO_x and MoO_x species, with V-O-Mo bonds being formed at the interfaces of the species. The effect of composition and structural features of the surface species formed in V_2O_5–MoO_3/Al_2O_3 catalysts on their catalytic properties are considered in details.

References

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2. Liu X., Duan L., Yang W., Zhu X., *RSC Adv*. **2017**, *7*, 34131.