

Oxidative Dehydrogenation of n-Butane on Vanadium-based catalysts prepared by grafting

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Introduction

The wide availability at low price of light alkanes has provided incentives for their use as raw materials in the chemical industry. An example of utilization of alkanes is their conversion to unsaturated hydrocarbons, which are currently produced in steam crackers (e.g., ethylene, propylene, isobutene, butadiene, etc.), because the present-day chemical industry depends heavily on the use of olefins as starting materials. Thus the petrolchemical industry's trend seems to be the direct use of alkanes as raw materials instead of alkenes, due to their great abundance. A relevant example concerns catalytic conversion of n-butane to butenes by oxidative dehydrogenation (ODH) as an alternative process to direct dehydrogenation. It is well known that supported vanadium pentoxide is a promising catalyst for the ODH of n-butane. Many papers and patents have been published on the preparation, characterisation and performances evaluation of catalysts prepared by impregnation. Very few papers, on the contrary, have been published on the catalysts prepared by grafting. In this work vanadium-based catalysts have been prepared following three different procedures. In the first procedure silica coated with a multilayer of titania, prepared by a multistep grafting of titanium alkoxide on silica, is used as a support for anchoring vanadium tri-isopropoxide. In the second procedure a titanium-vanadium bimetallic alkoxide is previously prepared by partial hydrolysis of a mixture of the two alkoxides and directly anchored on the silica surface. In the third procedure a mixture of the two alkoxides are directly anchored on silica surface by using different aprotic solvents, both polar and apolar. By comparing these catalysts prepared by grafting with the ones prepared by impregnation we observed an increase of the activities, due to the higher dispersion, accompanied by a strong increase in the selectivities. We have concluded that two factors are fundamental for favouring the ODH of butane: the dispersion of vanadium pentoxide favouring the activity and the prevalence of V-O-Ti bonds instead of V-O-V bonds, favouring the selectivity.