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Coach	Supervisor(s)	Funding
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Pt-based propane dehydrogenation catalysts: effect of In promotion, support and synthesis route.

Aim

This thesis aims at analysing the influence of three factors upon the performance of a Pt propane dehydrogenation (PDH) catalyst: the addition of In as a promoter element, the effect of the support material and the synthesis method. This can be achieved by in situ monitoring the bimetallic catalyst with characterization techniques, through which understanding of the synergy between the two elements and the support will be acquired. The latter can lead to better design of industrial catalysts.

Justification

Due to the importance of alkenes in the chemical industry, the catalytic dehydrogenation of alkanes into pure alkenes has been studied extensively. Supported Pt nanoparticles seem to be very appropriate as catalyst. Their stability, activity and selectivity can be improved by adding In as a promotor, to form bimetallic Pt-In particles.

The promotor in a bimetallic Pt cluster significantly influences the catalytic behaviour. Parameters such as atomic concentration and process temperature have a strong effect on the detailed structure of the nanocluster and as such, on the functioning of the catalyst. The support on the other hand can influence the activity and selectivity in a reaction based on its inherent properties (acidity, porosity, surface area, etc).

Pt-In catalysts can be prepared by wet chemical impregnation on a series of supports, like SiO_2, MgO, Al_2O_3, $MgAl_2O_4$, which can then be tested to study the support influence on the bimetallic performance. This can be compared with results from similar tests for samples prepared by a physical vapour synthesis, Atomic Layer Deposition (ALD), to assess the effect of both preparation methods on performance.

The interplay between the active element, promotor element and the support will be examined by means of characterization techniques (Figure 1, 2) and catalyst testing in reaction (Figure 3). The first will yield a physical description of the bimetallic catalyst in different conditions. The latter will elucidate the influence of promotor and support upon the catalytic behaviour.

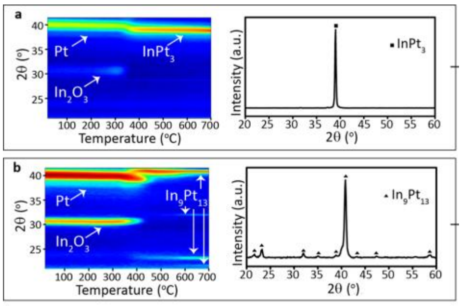

Figure 1: ***(left)*** *In situ XRD patterns during H_2-TPR of $Pt-In_2O_3/SiO_2$ with varying Pt/In ratio;* ***(right)*** *2θ XRD scans.*

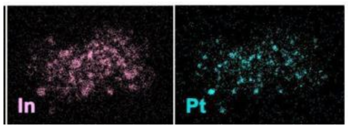

Figure 2*: HAADF-STEM image of a Pt-In/Mg(Pt)(In)(Al)O_x grain and corresponding EDX elemental maps.*

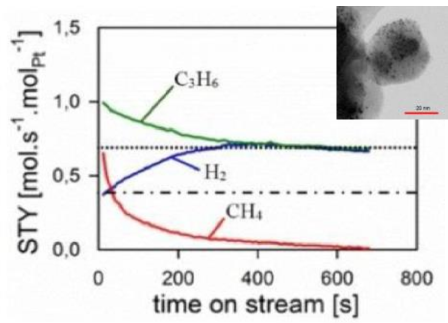

Figure 3: *performance of PtIn/Mg(In)(Al)O_x in terms of space time yields.* ***Inset:*** *STEM image of PtIn particle.*

Program

- Literature study on Pt-In catalysts and propane dehydrogenation.
- Synthesis of several supported Pt_xIn_y bimetallic particles.
- Sample characterization including, (S)TEM, TPR, TPD, TPO, NH_3-TPD, in situ XRD and DRIFTS measurements, to obtain the physicochemical characteristics of the catalysts.
- Reaction testing of the prepared catalysts in propane dehydrogenation (PDH).
- Time permitting: activity and carbon control by CO_2-assisted PDH

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