High Throughput Research on Propane Oxidative Dehydrogenation Catalysis

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Introduction

Propylene is one of the most important and highest volume chemicals in the industry. It is used in the synthesis of numerous industrial chemicals, intermediates, and polymers. Due to the increasing feedstock prices, alternative feedstock research is one of the major R&D efforts in Dow. Among several options for new routes to propylene, the use of propane as a feedstock to propylene and C_3 products provides an attractive potential for a low cost route. Oxidative propane dehydrogenation (ODH) is an appealing option because the energy requirement needed to overcome the endothermic propane dehydrogenation is mitigated [1-3]. Moreover, catalyst deactivation by coke deposition can be controlled potentially giving rise to a longer catalyst lifetime. However, to make this process commercially viable, new catalysts need to be developed which have significantly improved propane conversations and reduced combustion products.

Experimental

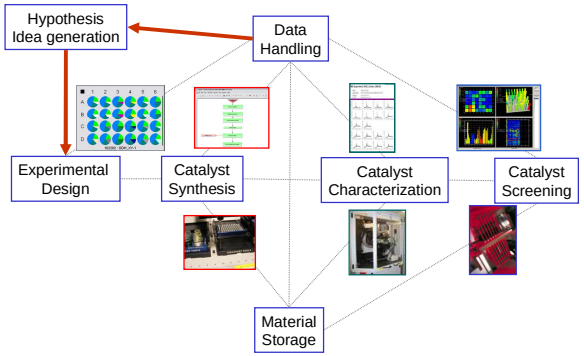
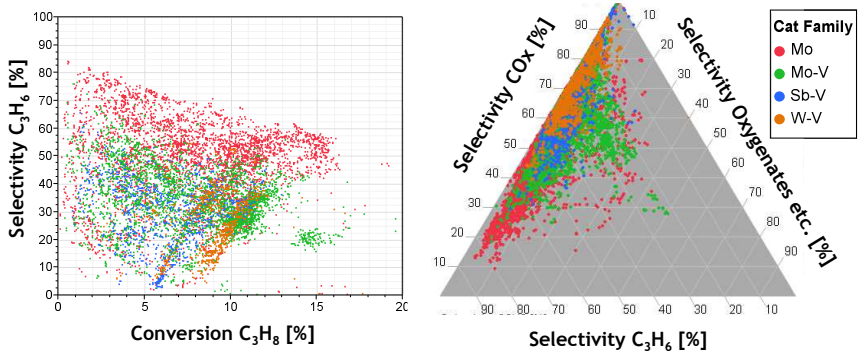


Figure 1. High Throughput Research workflow

The development of high throughput research (HTR) catalysis screening tools has greatly enhanced the speed and ability to deliver commercially viable catalysts and technology [4-5]. For truly effective catalytic HTR experimentation the workflow must consist of a series of interlocking elements consisting of experimental design, catalyst synthesis, materials characterization, and catalyst testing, aided by data handling and visualization software as illustrated in Figure 1.

The primary focus of the research program was directed at the investigation of both modified (known) partial oxidation catalysts and pure 'discovery' mixed metal oxide catalysts. Catalyst families covering different hypotheses were synthesized and tested using HTR synthesis and screening tools. In total, over 1000 catalysts were evaluated during a three-month HTR campaign.

Results/Discussion



(a) Selectivity to propylene and conversion (b) Selectivity ternary plot

Figure 2. Catalyst Performance on ODH

The catalyst performance results, selectivity and conversion, are shown in Figure 2. As a group, molybdate (Mo) exhibits the best performance for ODH, while molybdenum vanadate (Mo-V) led to propane to "propylene + oxygenates". Further compositional optimization including a dopants study will be presented together with an introduction to Dow's catalytic HTR workflows. Finally possibilities for process optimization will be discussed.

References.

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