



# Characterization of Nanostructured Binary Molybdenum Oxide Catalyst Precursors for Propene Oxidation

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## Abstract

Detailed characterization by means of TEM of molybdenum oxide catalyst precursors are carried out in order to get a better understanding of the mechanisms leading to the active catalytic material. The precipitated material consists of both large unit cell crystals and randomly oriented clusters in the 3-5 nm scale. The crystalline clusters are embedded in non-crystalline material preventing the formation of large well-defined orthorhombic MoO<sub>3</sub> crystals during activation of the catalyst material.

## 1. Introduction

The investigation of the detailed structure of molybdenum based mixed metal oxides is a central research topic in the understanding of catalysts for activation of small alkane molecules. Elemental and structural complexity is believed to be essential and is used in actual systems such as molybdenum-vanadium-tellurium-niobium oxides [Lin, 2001, Grasselli, 2002, Grasselli, 2001, Stern & Grasselli, 1997, Jr. et al., 2004] and Mo-V-W oxides [Knobl et al., 2003]. The bulk MoO<sub>3</sub> with well-defined orthorhombic structure is described to be fully inactive [Haber & Lalik, 1997, Lin, 2003] in alkane and alkene oxidation unless doped with another cation such as Sb, Bi or V [Grzybowska, 2002]. However, supported Mo oxides in the form of small aggregates containing both octahedral and tetrahedral building blocks are active in the activation of alkanes and alkenes [Chen et al., 2000, Chen et al., 2001, Radhakrishnan et al., 2001]. This and the fact that the majority of all selective oxidation catalysts contain Mo prompted us to re-investigate the issue about the inactivity of binary molybdenum oxide [Wagner et al., 2004, Wagner et al., 2005]. The target of such a study is confirmation of the essential presence of a second cation apart from Mo to achieve selective oxidation activity. Orthorhombic MoO<sub>3</sub> is obtained by a high-temperature calcination of various precursors [Haber & Lalik, 1997, Lin, 2003]. However, binary orthorhombic MoO<sub>3</sub> cannot be synthesized as primary product by precipitation. The primary products are a mixture of molybdenum oxide hydrates, of hexagonal MoO<sub>3</sub> and of a family of supramolecular oxo-clusters [Tytko et al., 1983, Tytko & Glemser, 1976, Müller et al., 2002]. Recently, we have studied the conditions and selection mechanisms that allow controlling the species obtained by aqueous precipitation [Hamid et al., 2003].