CHARACTERIZATION OF NANOSTRUCTURED BINARY MOLYBDENUM OXIDE CATALYSTS FOR PROPENE OXIDATION

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Binary molybdenum oxides are active catalysts for propene oxidation to acrolein if they are structurally different from orthorhombic MoO_3 (o-MoO_3). The periodical structure of the synthesized pre-catalyst must be different from o-MoO_3 to create the activity. Additional features typical for efficient catalysts are a bulk nanostructuring and a complex surface termination that are detectable in TEM examinations only.

Recently, we have studied the conditions and selection mechanisms that allow controlling the species obtained by aqueous precipitation of molybdenum oxides [1]. There is strong evidence from in-situ studies that orthorhombic MoO_3 is an active catalyst if it is suitably defected. Using time resolved X-ray absorption spectroscopy coupled to pulse response techniques it was possible to link the selective oxidation activity to the occurrence of lattice defects and to the beginning self-diffusivity of oxygen in o-MoO_3 [2,3]. Based on these studies it is plausible that defective molybdenum oxides may carry structural motifs, which are essential for the catalytic activity, and additional cations is at least a means of structural promotion helping to create/stabilize the defective state of orthorhombic molybdenum oxide.

Detailed characterization by means of TEM of the precipitated molybdenum oxides are carried out in order to get a better understanding of the mechanisms leading to the active catalytic material. The precipitated material consists of randomly oriented clusters in the 3-5 nm scale. The characteristic separations between the revealed lattice fringes are measured to be 0.34 nm and 0.37 nm, respectively. The crystalline clusters are embedded in non-crystalline material, separating the clusters preventing the formation of larger crystals.

It is believed that the observed clusters serve as seeds or building blocks for the final active catalyst developed under catalyst activation leading to the defective molybdenum oxides may carrying structural motifs, which are essential for the catalytic activity of selective propene oxidation toward acrolein.

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