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SYNTHESIS OF Mo–V–Te–Nb–O M1 PHASE-PURE CATALYST FOR PROPANE OXIDATION

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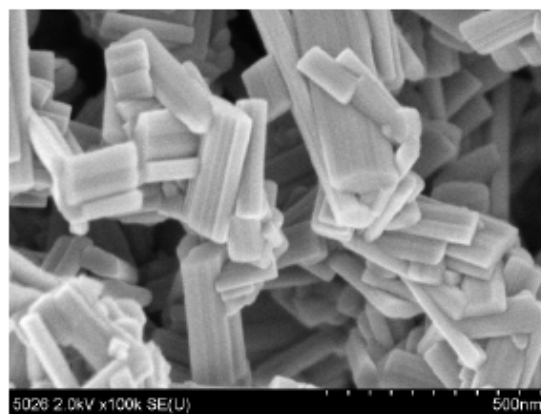
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Vanadium-containing multi-metal oxides show a great variety of chemical compositions, crystal structures, and properties. They have become a key constituent class of compounds because of their potential to be utilized in a direct catalytic oxidation/ammoxidation of alkanes. Recent advances in this area have demonstrated that a biphasic Mo–V–Te–Nb–O complex oxide¹ is one of the most promising catalysts for the selective oxidation and ammoxidation of propane to acrylic acid and acrylonitrile, respectively. In addition, the Mo–V–Te–Nb–O system demonstrates essential catalytic performance in oxidative dehydrogenation of ethane. Typically, this polycrystalline catalyst consists of two orthorhombic compounds, which are referred to as “M1” and “M2” phases,² however, the activity and selectivity in propane oxidation/ammoxidation are most likely related to the M1 phase, which is difficult to synthesize as phase pure material. Hence, there is considerable interest in the development of synthetic methods that can yield phase-pure Mo–V–Te–Nb–O M1 catalyst, exhibiting high specific surface area.

In the current study, we pursued a strategy that includes several stages to explore the title catalyst. The initial stage involves the preparation of the Mo-, V-, Te- and Nb-containing homogeneous complex solution. This solution is subsequently spray-dried and the resulting powdered product subjected to a moderate-temperature heat treatment. Then, Mo–V–Te–Nb–O complex oxide catalyst is prepared *via* the treatment of as-derived precursor in superheated water vapour, followed by thermal activation in argon (if applicable). During the latter stage, the key parameter of the synthesis – nominal molar ratio Mo:V:Te:Nb – was also studied. Finally, the as-prepared catalysts were subjected to detailed characterization studies employing various techniques.



The superheated water vapour treatment approach yields Mo–V–Te–Nb–O M1 phase product exhibiting specific surface area of ~ 20 m²/g and containing a small amount of metallic Te by-product. The thermal activation of as-derived powder at 650 °C for 2 hours in argon flow results in the M1 phase-pure catalyst with surface area of ~ 7 m²/g. The prepared catalysts consist of relatively large aggregates comprised of sharply faceted particles with rod-like morphology (see insert figure). The catalytic performance of synthesized Mo–V–Te–Nb–O M1 phase-pure powders is studied in the reaction of the selective oxidation of propane to acrylic acid and the corresponding characteristics of these catalysts are discussed.

1. Hatano, M.; Kayou, A. 1991 US Patent 5049692.

2. DeSanto, P.; Buttrey, D. J.; Grasselli, R. K.; Lugmair, C. G.; Volpe, A. F.; Toby, B. H.; Vogt, T. *Zeitschrift für Kristallographie* 2004, V. 219, p. 152.