

Elucidating Co/Mn dispersion on SiO₂ supported catalysts using transmission electron microscopy for enhancing FTS performance

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Introduction: The industrial FTS process utilizes Mn as a promoter for Co-based catalysts. The interaction of Mn with Co influences activity of catalyst and its selectivity to higher hydrocarbons.^[1] This study explores the role of Mn loading for Co/Mn distribution on supported catalysts in activated state such as metal segregation and electronic configuration changes that yield products with desired olefin-to-paraffin ratio.

Results: Co/Mn on SiO₂-based support catalysts with two different Mn compositions (below and above the optimum value for the best catalytic performance for this type of FT catalysts) were reduced under 10% H₂ at 500°C under atmospheric pressure to achieve the distribution of Co and Mn close to the activated state before FT reaction. The catalyst surfaces were subsequently passivated using 4% O₂, as the samples needed to be transferred in air to the TEM

setup. The influence of Mn on dispersion of Co atoms on the support and their own position relative to Co in such preserved state was studied via scanning transmission electron microscopy with energy-dispersive

spectroscopy (STEM-EDS) and high-angle annular dark-field (HAADF) imaging. Aggregated clusters of Co surrounded by Mn were formed in catalyst with high Mn loading (Figure 1a). For the catalyst with low Mn (figure 1b) loading more Mn atoms are seen on the support between the Co particles. High-resolution transmission electron microscopy (HRTEM) further revealed differences in distribution of intermediate-range order nanocrystalline phases as a function of Mn content.

This study demonstrates the advantage of EDS measurements where specific atoms can be visualized and promotes the need for *in-situ* studies to reveal structure-activity relationships in Co-based FT catalysts to optimize them for industrial applications.

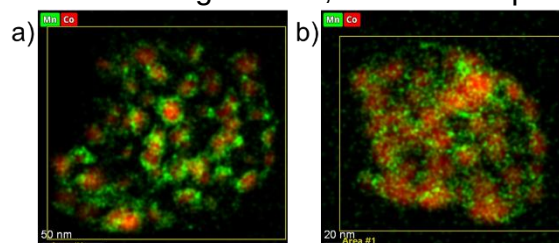


Figure 1: EDS map of Co (red color) and Mn (green color) distribution for the two samples with different amounts of Mn loading in activated state.