

The effect of Mn content on the reduction of Co-based model catalysts and their performance in FTS

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Introduction

For Co-based FTS technologies to be commercially successful, and implemented in power-to-liquid plants, a high selectivity of C₅₊ hydrocarbons and a low selectivity of CO₂ and CH₄ are required. This is a focus of the CARE-O-SENE project, a German-South African project funded by BMBF (German Federal Ministry of Education and Research). Research has shown that cobalt promotion with manganese improves CO adsorption/dissociation by facilitating oxygen removal, thus, improving the C₅₊ selectivity and minimizing CH₄ formation. Studies have concluded that sites near a Co-MnO interface lead to a strengthened Co adsorption and a weak C-O surface bond, ultimately enhancing the C₅₊ selectivity and TOF.^{1, 2}

Focussing on the development and optimization of modified silica supported catalysts, Mn_{0.15}Co_{2.85}O₄ model catalysts with varied crystallite size were prepared for optimal FT performance with further investigation into different Mn promoter contents on the reduction behaviour of all catalysts and nanoparticles using *in situ/operando* techniques, viz. XRD and magnetometry. All catalysts were prepared using a surfactant-free approach with benzyl alcohol in the synthesis to enable size control.³ The reduction to Co⁰ remained largely unhindered by Mn, and complete reduction was achieved at 450 °C. The catalyst with the smallest crystallites (5 nm) was found to reduce first which was attributed to a kinetic effect whereby spillover H₂ from MnO facilitated the reduction of Co₃O₄ (Fig. 1).

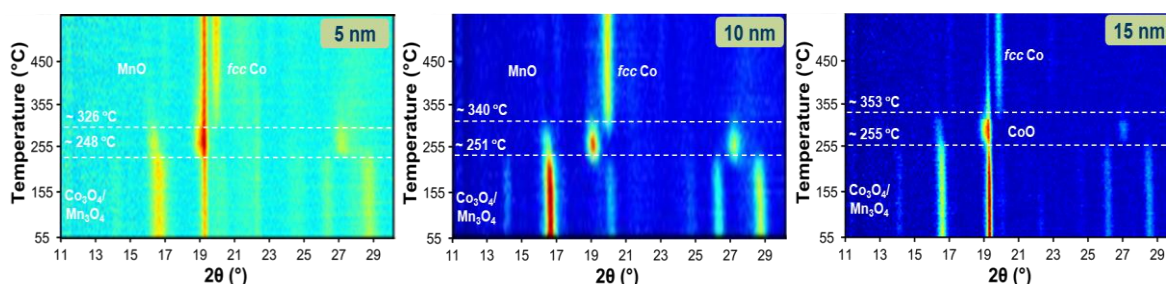


Figure 1: *In situ* XRD of supported Mn_{0.15}Co_{2.85}O₄ model catalysts.

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- (2) Johnson, G. R.; Werner, S.; Bell, A. T. *ACS Catal.* **2015**, *5*, 5888-5903.
- (3) Wolf, M.; Fischer, N.; Claeys, M. *Mater. Chem. Phys.* **2018**, *213*, 305.