

An *in-situ* study on the reduction and carburization of model cobalt catalysts: exploring the influence of particle size

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The production of sustainable aviation fuels (SAF) is crucial for recycling carbon within the global energy sector. The Fischer-Tropsch synthesis (FTS) offers an appealing and practical method for producing SAF, making it a focal point for CARE-O-SENE, a German-South African project funded by BMBF (German Federal Ministry of Education and Research). In low-temperature FTS (LTFTS), cobalt (Co)-based catalysts are industrially utilized for the selective production of long-chain hydrocarbons (C_{5+}) from syngas, which can be further processed (*e.g.*, through hydrocracking) to yield the SAF fraction (C_{8-16}) [1].

To improve the activity, selectivity, and stability to C_{5+} hydrocarbons over Co-based FTS catalysts, these metal catalysts are anchored on an oxidic support, namely, alumina, silica, or titania [2]. In this study, a titania-coated silica sphere support material is suggested to mimic the titania dispersions present on an industrial alumina-based support, as reported elsewhere [3], to assist with the dispersion of cobalt oxide on the support. These Co-based catalysts are susceptible to carburization under FTS conditions, which (partially) converts metallic cobalt to a cobalt carbide phase (Co_2C) that encourages methane formation and decreases the selectivity to long-chain hydrocarbons (C_{5+}) [4]. Because the Fischer-Tropsch synthesis is recognized as a size-dependent reaction [5], it is crucial to investigate how the starting size of cobalt oxide particles on this model support affects their reduction to metallic cobalt and subsequent carburization, as shown in Fig. 1.

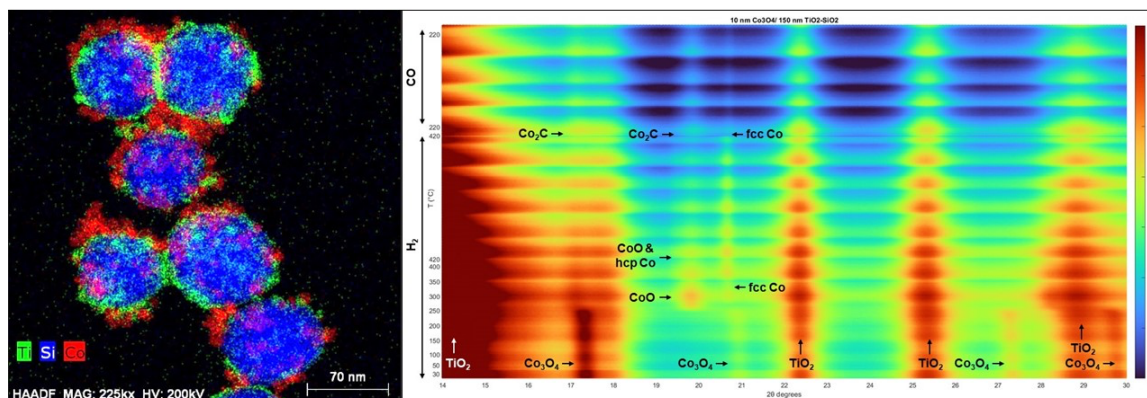


Figure 1. (left) STEM-EDX micrograph of Co₃O₄ nanoparticles dispersed on a model TiO₂-coated SiO₂ support spheres. (right) Reduction of Co₃O₄ in H₂ (12ml/min) and carburization of metallic cobalt in CO (3ml/min) plot as studied *via in situ* XRD.

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