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The Influence of Different Mn-Co interaction Modes in $Mn/Co/TiO_2$ Fischer-Tropsch Catalysts

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The unpredictable turbulence of crude oil prices has largely defined the prominence of research towards alternative fuel processes, most notably the Fisher Tropsch (FT) process [1]. The Cobalt based FT catalysts are well known for their activity and stability [2]. In general, cobalt catalysts exhibit both higher activity and selectivity than their iron counterparts. For FT synthesis, Mn is often used as a promoter for both supported and unsupported Co catalysts [3].

The addition of promoter onto supported metal catalysts is a prevalent way in making catalysts to enhance the reactivity results, but it is also a poorly understood phenomenon in heterogeneous catalysis. Being a local effect, intimate interaction of the promoter and the metal is highly desired; therefore, a key design objective is to increase the promoter-metal interactions to maximize their effectiveness. We achieved this goal of creating a monolayer of Mn promoter on Co metal (confirmed by STEM-EELS) by using the Strong Electrostatic Adsorption (SEA [4]), which utilizes pH control to steer the promoter precursor (in this case MnO_4^-) onto Co oxide supported on TiO_2. And this type of catalyst showed promising Fischer Tropsch (FT) reactivity results in the catalytic testing by comparing with our previous studied FT catalysts, which are Mn promoted on Co/TiO_2 by SEA (partial but not core-shell interaction) and Mn promoted on Co/TiO_2 by Dry Impregnation (most common way of catalysts synthesis in industry but least promoter-metal interaction).

In this presentation, the microscopy results (imaging and EELS mapping, Figure 1 and 2) is linked with the CO hydrogenation reactivity results (Figure 3) to show how will the different promoter-metal interactions affect the FT reaction of producing long chain hydrocarbons.

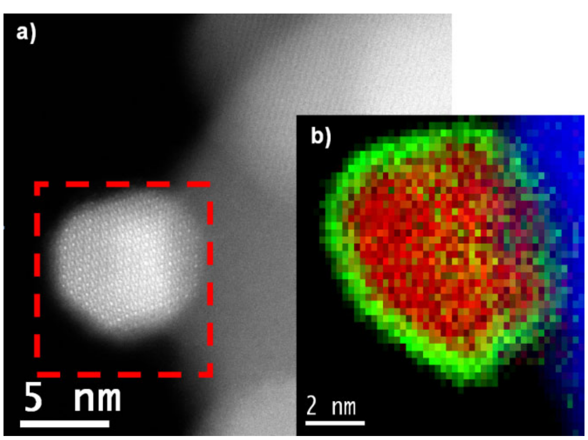

Figure 1: . a) Atomic resolution Z contrast imaging of monolayer Mn promoted Co catalyst supported on TiO_2. b) EELS mapping showed distinct elemental composition, in the graph, green is Mn, red is Co and blue is TiO_2. Imaging and spectra acquired from Oak Ridge National Laboratory by using a Nion UltraSTEM.

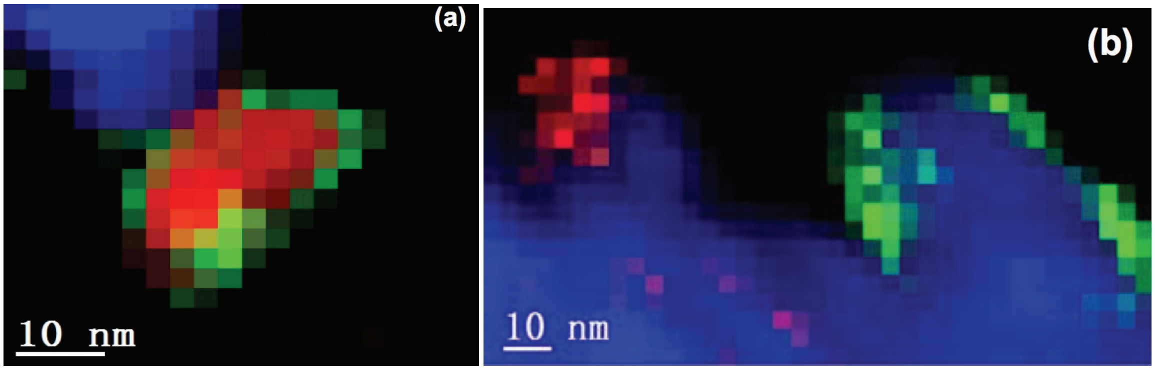

Figure 2 a) EELS mapping of $Mn^{SEA\_partial}/Co/TiO_2$ catalys, b) EELS mapping of $Mn^{DI}/Co/TiO_2$ catalyst, in the graph, green is Mn, red is Co and blue is TiO_2. Imaging and spectra acquired from UIC RRC center by using JEOL-2010 STEM.

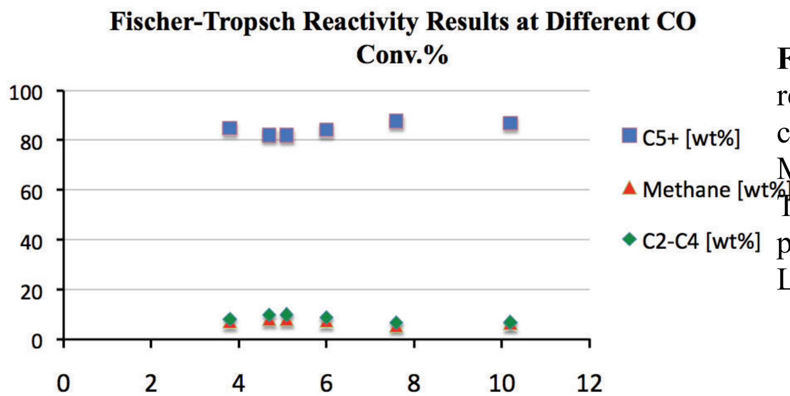

Figure 3: Fischer-Tropsch reactivity results at various CO conversion point by using the $Mn^{SEA\_monolayer}/Co/TiO_2$ catalyst. The FT catalytic testing was performed at Argonne National Laboratory.

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