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Low-temperature hydrogenation of carbon dioxide to methanol using a homogeneous cobalt catalyst

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Methanol attracts significant attention as a hydrogen storage material (12.5 wt % H_2), drop-in liquid fuel as well as an energy carrier in methanol fuel cells. Its industrial utility combined with these promising energy applications has led to multiple proposals of a so-called "Methanol Economy" in which methanol would be the central carbon and energy feedstock in a sustainable energy economy. Currently, methanol is produced from fossil fuels, especially natural gas, via syngas (mixture of CO, CO_2 and H_2). For a more sustainable production of methanol direct reduction of CO_2 is a highly interesting option if green hydrogen or renewable energy is used. In such a way it would be possible to recycle atmospheric carbon as part of a carbon capture and recycling strategy (CCR), avoiding additional CO_2 emissions and replacing non-sustainable carbon sources. So far, hydrogenation of CO_2 to methanol has been studied intensively using heterogeneous catalysts. Hence, a large library of active catalysts has been developed but most require high temperatures (>200 °C) to operate. Herein, we describe the first homogeneous non-noble metal catalyst for the hydrogenation of CO_2 to methanol. The *in-situ* formed catalyst based on $Co(acac)_3$/Triphos/$HNTf_2$ allows to perform the reaction at 100 °C without a decrease in activity. Kinetic, *in-situ* NMR and MS studies suggest an inner-sphere mechanism catalyzed by a cationic cobalt/Triphos complex, which is formed after slow removal of the acac ligands. We hope that this report will inspire the development of novel, homogeneous non-noble metal based catalysts for a cost and energy efficient hydrogenation of CO_2 to methanol.

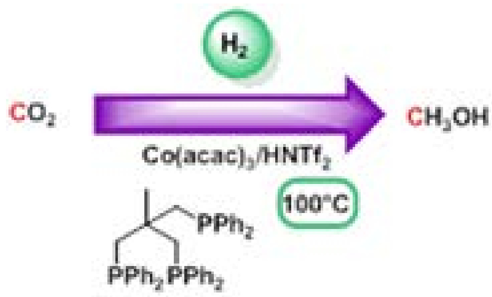

Figure: Low-Temperature Hydrogenation of Carbon dioxide to Methanol Using a Homogeneous Cobalt Catalyst

Biography

Rauf Razzaq has his expertise in both Homogeneous and Heterogeneous Catalysis: material design, synthesis and application. Recently, Mr. Razzaq is busy with designing novel catalytic systems for efficient CO_2 valorization. He has also good experience in chemical reaction engineering and reactor design. During his research he has not only studied the effect of various metals in catalyzing the CO_2 hydrogenation reaction but has done some extensive work on understanding the influence of the type of catalytic reactor during such reactions. This approach carries a significant importance in applied catalysis especially in scale-up from lab to pilot and then industrial scale.

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