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Press release

Chemical conversion of CO_2 possible with catalysts based on cheap and environmentally friendly manganese
New Mn-complex enables catalytic reduction of CO_2 and carbonyl groups

Prof. Walter Leitner, director of the Molecular Catalysis Department at the Max Planck Institute for Chemical Energy Conversion (MPI CEC) and his team developed a new manganese catalyst capable of reducing carbon dioxide and other challenging substrates in a highly selective manner.

The quest for new chemical transformations to generate value from non-fossil resources is a major challenge and opportunity for innovation towards sustainable chemical processes. From an ecological and economic standpoint, the efficient reduction of carbonyl groups, i.e. molecular units with a carbon-oxygen double bond, is highly desirable in this context. Especially the C=O units in carboxylic acids and carbonic acid derivatives, including ultimately carbon dioxide itself, are notoriously difficult to be reduced under mild conditions. The derived alcohols constitute valuable building blocks for the synthesis of fuels, plastics and fertilizers on a bulk chemical scale and serve as starting materials in the pharmaceutical industry.

Catalysis remains the most potent method to overcome the energy barriers associated with challenging reduction reactions. So far, the considered catalysts are mostly noble metals such as rhodium or platinum, which are expensive and whose mining is associated with high environmental burdens. Recent scientific progress has provided evidence that novel catalysts based on earth-abundant, cheap, and benign metals such as iron or manganese might hold great promise as possible alternatives.

In a paper published in the Journal *Nature Communications*, Walter Leitner and coworkers now report for the first time the manganese-catalyzed hydroboration of carbon dioxide and other challenging carbonyl groups.

The hydroboration, i.e. the addition of a Boron-Hydrogen bond to a C=O unit, is a widely used transformation for the reductive functionalization of carbonyl groups. It is, however, currently restricted only to very reactive substrates in combination with Platinum-group metal catalysts. The breakthrough to extend this principle to carboxylic acids, carbonic acid derivatives, and CO_2 was achieved by judicious design of the molecular framework

around the active Manganese center. In addition to demonstrating the efficient and highly selective reduction for a broad range of substrates, the team was also able to capture a key intermediate of the catalytic cycle and to elucidate its molecular structure by X-ray crystallography.

Following the principles of Green Chemistry, the described synthetic protocols and the molecular insight from this work define a breakthrough towards the development of new catalytic systems based on cheap and benign catalysts for sustainable processes enabling in particular the use of non-fossil carbon feedstocks derived from biomass or carbon dioxide.

Further information about the work can be found in:
Kaithal, A., Sen , S., Erken, C., Weyhermüller, T., Hölscher, M., Werlé, C., Leitner, W., (2018). Manganese-catalyzed hydroboration fo carbon dioxide and other challenging carbonyl groups, Nature Communications, DOI: 10.1038/s41467-018-06831-9 I

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