Active site engineering for heterogeneous catalysis using emerging nano-structured materials

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The growing concern about the depletion of oil has spurred worldwide interest in finding alternative feedstocks for important petrochemical commodities and fuels. On the one hand, the enormous reserves found (208 trillion cubic feet proven[1]), environmental sustainability and lower overall costs point to natural gas as the primary source for energy and chemicals in the near future.[2] Nowadays the transformation of methane into useful chemicals and liquid fuels is only feasible via synthesis gas, a mixture of molecular hydrogen and carbon monoxide, that is further transformed to methanol or to hydrocarbons under moderate reaction conditions (150-350 °C and 10-100 bar).[3] For a major cost reduction and in order to valorize small natural gas sources, either more efficient "syngas to products" catalysts should be produced or the manner in which methane is initially activated should be changed, ideally by developing catalysts able to directly oxidize methane to interesting products such as methanol. On the other hand, from the point of view of CO_2 emissions, the use of the remaining fossil resources will further contribute to global warming. In this scenario, the development of efficient routes for the transformation of CO_2 into useful chemicals and fuels would represent a considerable step forward towards sustainability. Indeed, the environmental and economic incentives to develop processes for the conversion of CO_2 into fuels and chemicals are great. However, for such conversions to become economically feasible, considerable research is necessary. In this lecture we will summarize our recent efforts into the design of new catalytic systems, based on MOFs and COFs, to address these challenges. Examples include the development of new Fe based FTS catalysts, electrocatalysts for the selective conversion of CO_2 into syngas, the development of efficient catalysts for the utilization of formic acid as hydrogen storage vector and the development of new enzyme inspired systems for the direct transformation of methane to methanol under mild reaction conditions.

References

(1) *http://www.clearonmoney.com/dw/doku.php?id=public:natural_gas_reserves*.
(2) Derouane, E. G.; Parmon, V.; Lemos, F.; Ribeiro, F. R. *Sustainable Strategies for the Upgrading of Natural Gas: Fundamentals, Challenges, and Opportunities*; Springer, 2005.
(3) Rofer-DePoorter, C. K. *Chemical Reviews*. ACS Publications 1981, pp 447–474.