Bio-inspired strategies for the design of electrocatalysts for small molecule activation

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Selective electrochemical reduction of small molecules (CO₂, NOx, NO₃⁻) into energy-dense chemicals is a promising strategy for using these waste materials as raw carbon and nitrogen sources. However, efficient and selective earth abundant metal catalysts for promoting these reactions are still scarce. We will present here an array of strategies inspired from biological systems to promote these reactions with high selectivity and efficiency. The importance of tackling these challenging reactions at multiple scales will be illustrated by a series of molecular and heterogeneous catalysts replicating enzymatic features, from their active sites including secondary features such as hydrophilic and hydrophobic domains to the overall shape of organs involved in gas trapping. A special focus will be given to electron and proton transfer processes using iron-sulfur clusters, and the development of CPET mediators for the facile electrochemical generation of hydride species.