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Sommario/riassunto

Society is currently confronted with the continuing environmental problems of global warming and ocean acidification related to increasing CO_2 emission from anthropogenic sources. These environmental issues are also connected to the inevitable energy supply shortage due to the eventual depletion of fossil fuel sources. As a solution, the technology of recycling CO_2 into useful organic materials continues to attract attention. This methodology can be categorized into two main parts: CO_2 fixation and CO_2 reduction. For both reactions, molecular catalysts based on transition metal coordination complexes and organometallic compounds have been developed and examined. Molecular catalysts can be characterized and iteratively improved at the molecular level through spectroscopic experiments and the isolation of intermediate species, which is particularly advantageous in comparison to heterogeneous catalysts. The fixation of CO_2 into organic compounds to form a carbon-carbon bond by using organometallic catalysts is a direct methodology for CO_2 utilization and represents the potential reversible storage of electrochemical energy in chemical bonds. The resultant carboxylic acid-containing compounds formed as the initial products can be subsequently converted into other organic materials, even products with new chiral centers. The reduction of CO_2 by two electrons (often with a proton donor as a co-substrate) yields carbon monoxide (CO) and formic acid (HCOOH), which can be further converted to useful

chemicals. Reduction reactions involving more than two electrons and two protons can produce formaldehyde (HCHO), methanol (CH_3OH), and methane (CH_4), which are also desirable as chemicals and fuels. For molecular electrocatalysts, more negative potentials than the equilibrium ones for CO_2 reduction are generally required; the difficulty is that the equilibrium potentials for CO_2 reduction are generally negative of the equilibrium potential for proton reduction to produce H_2, representing a competing thermodynamically favored process. A complementary approach to an electrochemical one is to mediate CO_2 reduction with photo-induced electron transfer reactions. Photo- and electrocatalytic CO_2 reduction can be used to achieve artificial photosynthesis, or the production of commodity chemicals and fuels with renewable energy inputs originating from solar sources. This Research Topic covers the molecular catalysts based on coordination and organometallic compounds for CO_2 fixation/reduction. It includes chemical, electrochemical, and photochemical reactions. It also covers systematic studies of reaction mechanisms and the spectroscopic characterization of catalytic intermediates. Molecular catalysts for CO_2 fixation/reduction used as co-catalysts with heterogeneous catalytic systems are also included. Non-precious and abundant transition metal catalysts for CO_2 fixation/reduction are important for future industrial applications as core components of the next generation of energy technologies.