

Molecular (Photo)Electrochemical Reduction of CO₂ to C1 products with 2, 4, 6 and 8 Electrons. From Mechanistic Studies to Hybrid Systems.

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Reduction of carbon dioxide has as main objective the production of useful organic compounds and fuels - *renewable fuels* - in which solar energy would be stored. Molecular catalysts can be employed to reach this goal, either in electrochemical or photochemical contexts. They may in particular provide excellent selectivity thanks to easy tuning of the electronic properties at the metal and of the ligand second and third coordination sphere. Recently it has been shown that such molecular catalysts may also be tuned for generating highly reduced products such as methanol and methane, leading to new exciting advancements.

Hybridization of these catalysts with conductive or semi-conductive materials may lead to enhance stability and new catalytic properties, as well as inclusion of molecular catalysts in devices for applications. This approach bridges between homogeneous and heterogeneous, and it raises new fundamental questions that may further lead to breakthrough in CO₂ reduction chemistry.

Our recent results in these various areas will be discussed.

1. B. Ma, M. Blanco, G. Drazic, L. Calvillo, L. Chen, G. Chen, T.-C. Lau, J. Bonin, G. Granozzi, M. Robert *J. Am. Chem. Soc.* **2021**, 143, 22, 8414-8425.
2. E. Boutin, M. Robert, *Trends in Chemistry*, **2021**, 3, 359-372.
3. P. B. Pati, E. Boutin, R. Wang, S. Diring, S. Jobic, N. Barreau, F. Odobel, M. Robert, *Nat. Commun.* **2020**, 11:3499.
4. B. Ma, G. Chen, C. Fave, L. Chen, R. Kuriki, K. Maeda, O. Ishitani, T-C. Lau, J. Bonin, M. Robert, *J. Am. Chem. Soc.* **2020**, 142, 6188-6195.
5. S. Ren, D. Joulie, D. Salvatore, K. Torbensen, M. Wang, M. Robert, C. Berlinguette, *Science* **2019**, 365, 367-369.
6. E. Boutin, M. Wang, J. C. Lin, M. Mesnage, D. Mendoza, B. Lassalle-Kaiser, C. Hahn, T. F. Jaramillo, M. Robert, *Angew. Chem. Int. Ed.* **2019**, 58, 16172-16176.
7. Z. Guo, C. Cometto, G. Chen, L. Chen, B. Ma, H. Fan, T. Groizard, W-L. Man, S-M. Yiu, K-C. Lau, T-C. Lau, M. Robert, *Nat. Catal.* **2019**, 2, 801-808.
8. H. Rao, L. Schmidt, J. Bonin, M. Robert, *Nature* **2017**, 548, 74-77.
9. I. Azcarate, C. Costentin, M. Robert, J-M. Savéant, *J. Am. Chem. Soc.* **2016**, 138, 16639-16644.
10. C. Costentin, S. Drouet, M. Robert, J-M. Savéant, *Science* **2012**, 338, 90-94.