Coupling Molecules and Materials for the Photochemical Catalytic Reduction of CO_2

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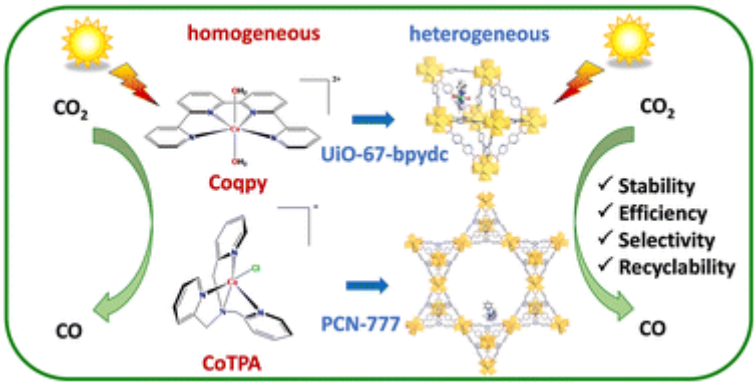

Facing the current environmental and energy crisis, the activation of small molecules such as water, molecular oxygen, molecular nitrogen and carbon dioxide represents a main research challenge. In particular, the utilization of solar energy combined to catalysts made of abundant and non-toxic materials to generate C1 building blocks (carbon monoxide, formaldehyde) and energy vectors (methanol, methane) is a strategic objective.

To efficiently convert sunlight into electrons and then into chemical energy stored in molecular bonds, either by photochemical or photoelectrochemical ways, chemical processes require a selective and robust catalysis with desired properties, which necessitates the intimate understanding of the reaction mechanism at the molecular scale.

In this presentation, I will give some examples of the most recent studies developed in the REACTE group at LEM on the association of molecular catalysts with materials (carbon nitride[1], graphene derivatives[2], MOFs[3]) to efficiently use solar light to achieve the catalytic reduction of CO2 into CO and beyond[4,5].

References

1. Ma, B.; Chen, G.; Fave, C.; Chen, L.; Kuriki, R.; Maeda, K.; Ishitani, O.; Lau, T.-C.; Bonin, J.; Robert, M., Efficient Visible-Light-Driven CO_2 Reduction by a Cobalt Molecular Catalyst Covalently Linked to Mesoporous Carbon Nitride. *J. Am. Chem. Soc.* **2020**, 142 (13), 6188-6195.

2. Ma, B.; Blanco, M.; Calvillo, L.; Chen, L.; Chen, G.; Lau, T.-C.; Dražić, G.; Bonin, J.; Robert, M.; Granozzi, G., Hybridization of Molecular and Graphene Materials for CO2 Photocatalytic Reduction with Selectivity Control. *J. Am. Chem. Soc.* **2021**, 143 (22), 8414-8425.

3. Parshamoni, S.; Viravaux, C.; Robert, M.; Mellot-Draznieks, C.; Chen, G.; Mialane, P.; Dolbecq, A.; Bonin, J., Heterogenization of molecular cobalt catalysts in robust metal–organic frameworks for efficient photocatalytic CO_2 reduction. *Catal. Sci. Technol.* **2022**, 12, 5418-5424.

4. Wang, R.; Boutin, E.; Barreau, N.; Odobel, F.; Bonin, J.; Robert, M., Carbon Dioxide Reduction to Methanol with a Molecular Cobalt-Catalyst-Loaded Porous Carbon Electrode Assisted by a CIGS Photovoltaic Cell. *ChemPhotoChem* **2021**, 5 (8), 705-710.

5. Navarro-Jaén, S.; Virginie, M.; Bonin, J.; Robert, M.; Wojcieszak, R.; Khodakov, A. Y., Highlights and challenges in the selective reduction of carbon dioxide to methanol. *Nature Rev. Chem.* **2021**, 5 (8), 564-579.