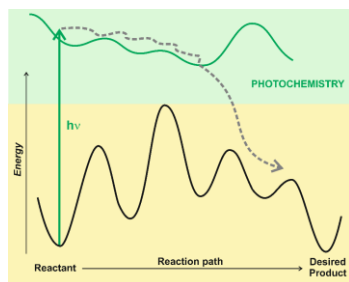
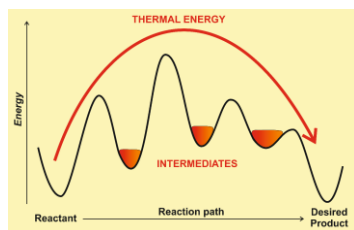


Photocatalysis

- **photochemistry** - uses light to promote a reaction
- **photocatalysis** – catalysis in the presence of light
- **photoredox catalysis** - the excitation of a catalyst leads to an electron transfer and thus to the oxidation/reduction of a reactant



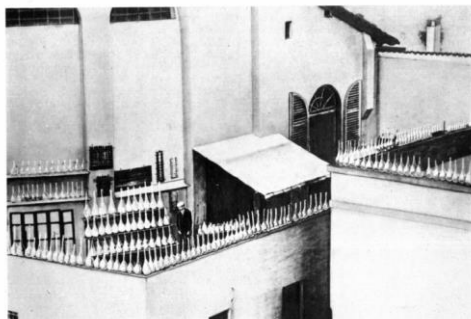
Giacomo Ciamician (University of Bologna)

1912: need for an energy transition to renewable energy

- use of solar energy to produce fuel
- vision of artificial photosynthesis



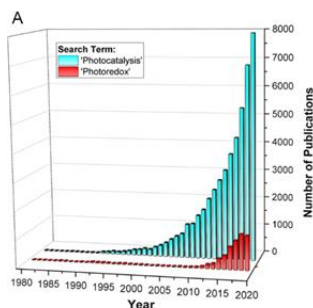
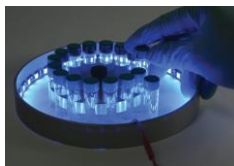
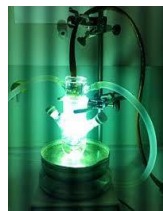
G. Ciamician



CIAMICIAN passant en revue les centaines de flacons exposés au soleil sur le toit de son laboratoire.

Ciamician, G. The photochemistry of the future. *Science* 1912, 36, 385–394.

Reactions in batch and in flow



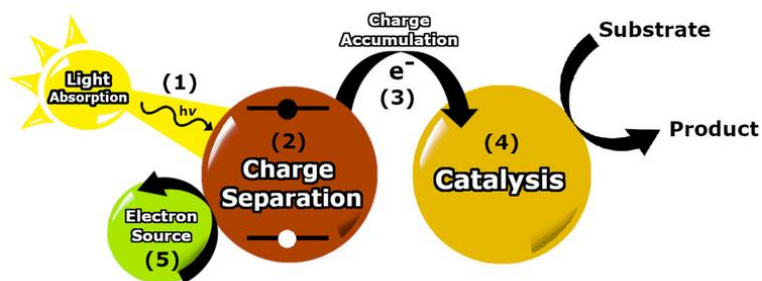
Process-scale photoredox flow reactor at Merck.

Photo courtesy of Merck and Co. Inc.

Borman, S. *Chem. Eng. News* **2015**, 93, 33.

C. G. Thomson, A. L. Lee, F. Vilela, *Beilstein J. Org. Chem.* **2020**, 16, 1495.

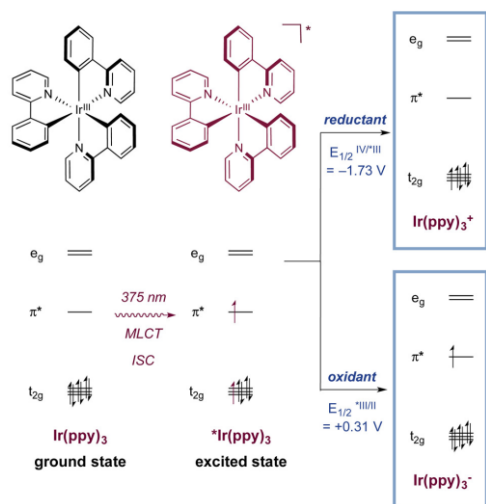
Light-Driven Catalysis



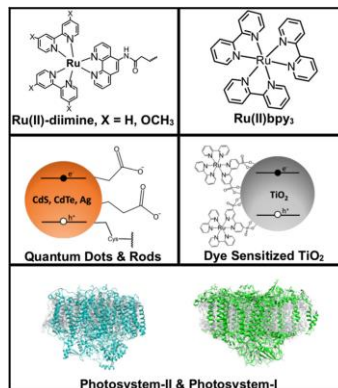
E. H. Edwards, K. L. Bren, *Biotech. Appl. Biochem.* **2020**, 67, 463.

→ Photoredox catalysis

Photocatalysts

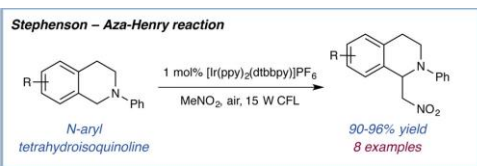


- max absorption at 375 nm (vis)
- long-lived excited state ($\tau=1.9 \mu\text{s}$)
- single-electron transfer
- effective oxidant and reductant
- triplet state $\rightarrow 56 \text{ kcal mol}^{-1}$

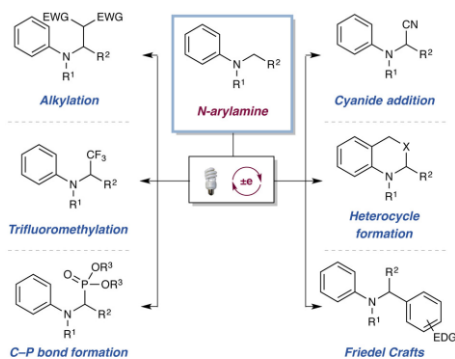
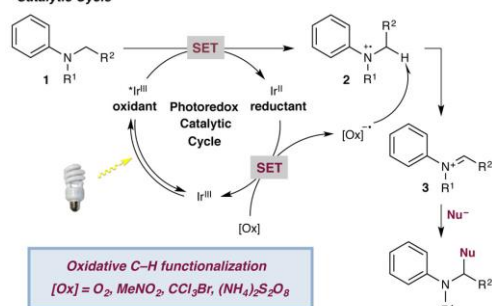


M. H. Shaw, J. Twilton, D. MacMillan, *J. Org. Chem.* **2016**, *81*, 6898–6926.
 E. H. Edwards, K. L. Bren, *Biotech. Appl. Biochem.* **2020**, *67*, 463.

Photoredox catalysis



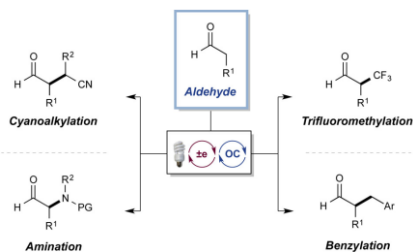
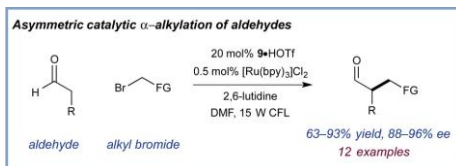
Catalytic Cycle



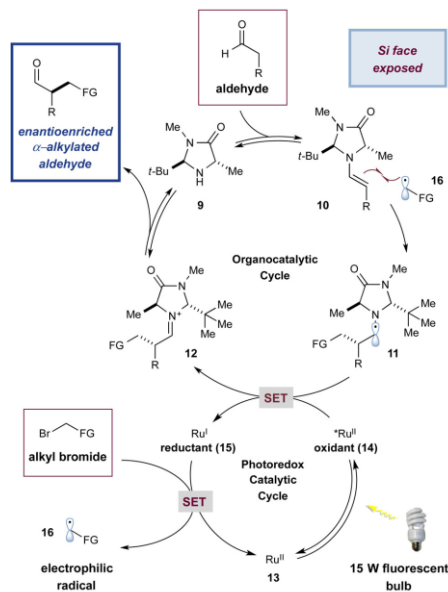
M. H. Shaw, J. Twilton, D. MacMillan, *J. Org. Chem.* **2016**, *81*, 6898–6926.

Dual photoredox catalysis

- combination of photoredox catalysis with organocatalysis

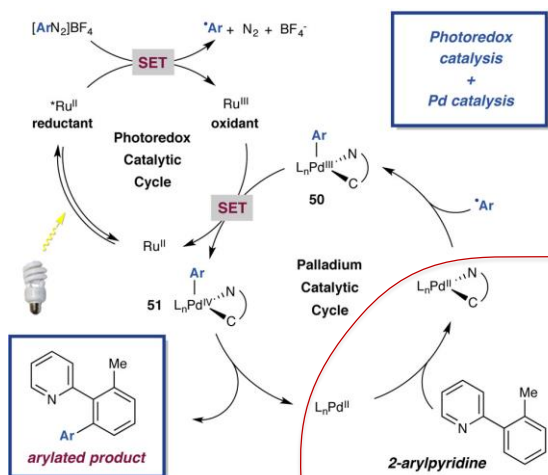
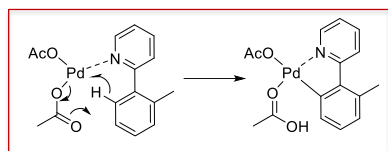
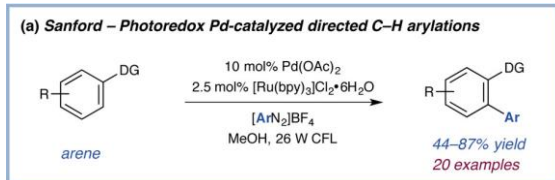


M. H. Shaw, J. Twilton, D. MacMillan, *J. Org. Chem.* **2016**, *81*, 6898–6926.



Metallaphotoredox catalysis

- combination of photoredox catalysis with transition metal catalysis



M. H. Shaw, J. Twilton, D. MacMillan, *J. Org. Chem.* **2016**, *81*, 6898–6926.

Learning objectives

- You should
 - understand and be able to explain principles of photocatalysis.
 - know an example of a photocatalyst and modes how this photocatalyst can engage in chemical reactions.
 - know what dual photoredox catalysis is.
 - know what metallaphotoredox catalysis is

Do the quiz and
see you in the class!

