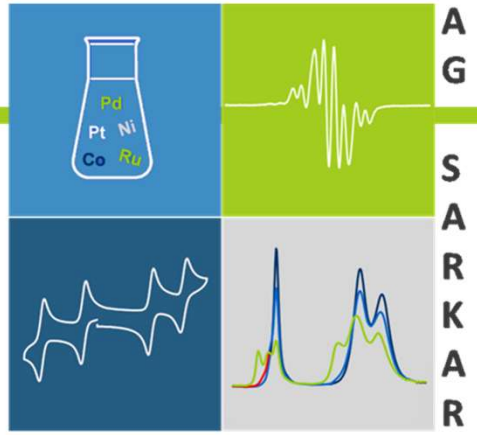


AG SARKAR

Freie Universität Berlin

AG Sarkar: Where Catalysis and Switching meet (Spectro)electrochemistry

Prof. Dr. Biprajit Sarkar

15.11.24

Research and Drinks

Research Topics: Sarkar Group

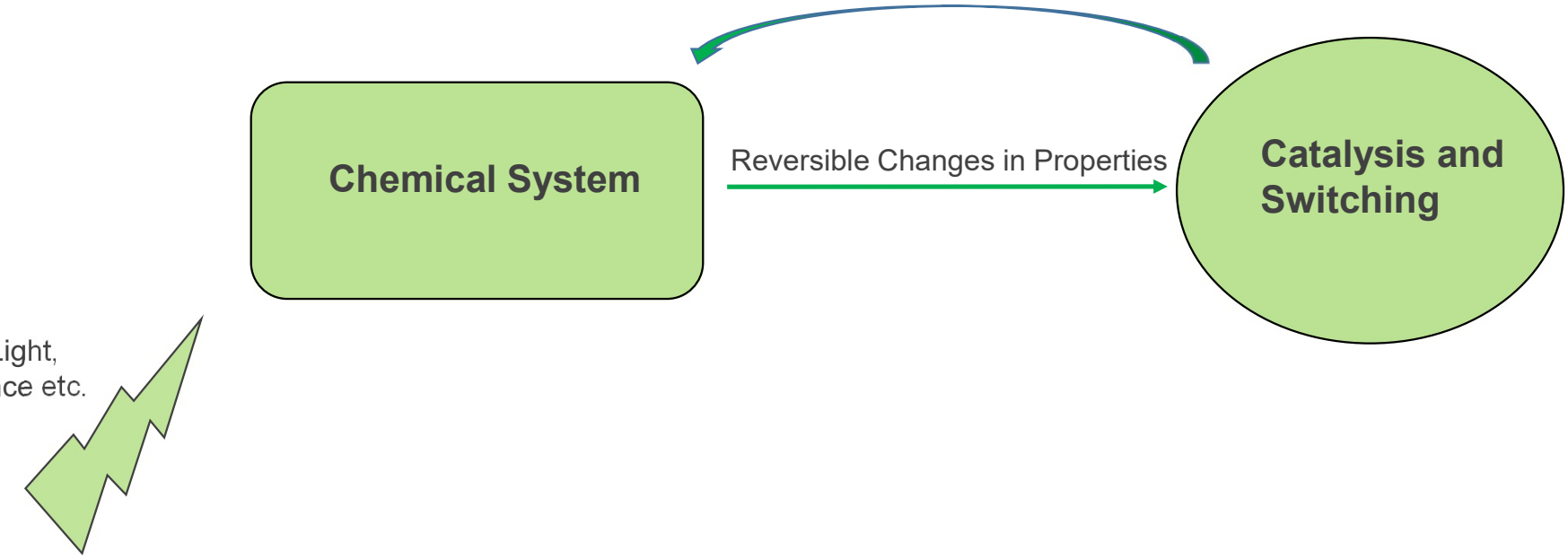
- ✓ **Switchable Systems for Magnetic and Optoelectronic (Near-IR, Electrochromic) Molecular Materials**

- ✓ **Metal Complexes for Activation and Production of H_2 and Activation of O_2, CO_2 and (H_2O)**

- ✓ **Stimuli Responsive Homogenous Catalysis**
  - (Transfer)hydrogenation of various functionalities
  - C-H Functionalization, Oxidation Catalysis
  - Cyclization reactions, (Polymerization Catalysis)

- ✓ **Reagents for Bioorthogonal Chemistry**

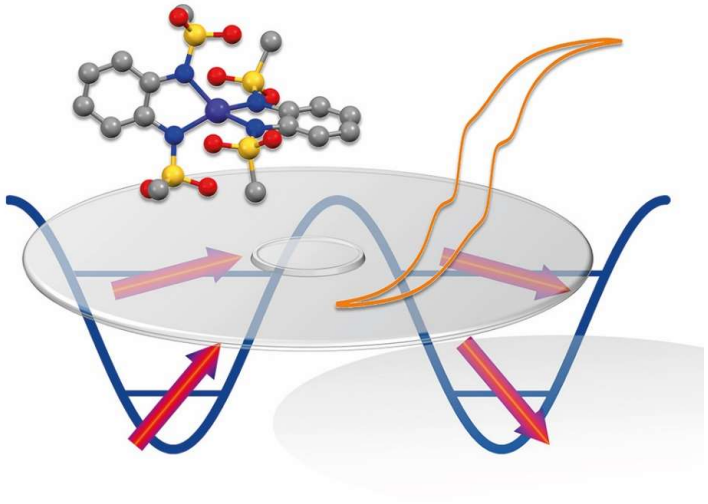
Binding Theme: Sarkar Group



External Perturbation

Relevance of the Topics: Sarkar Group

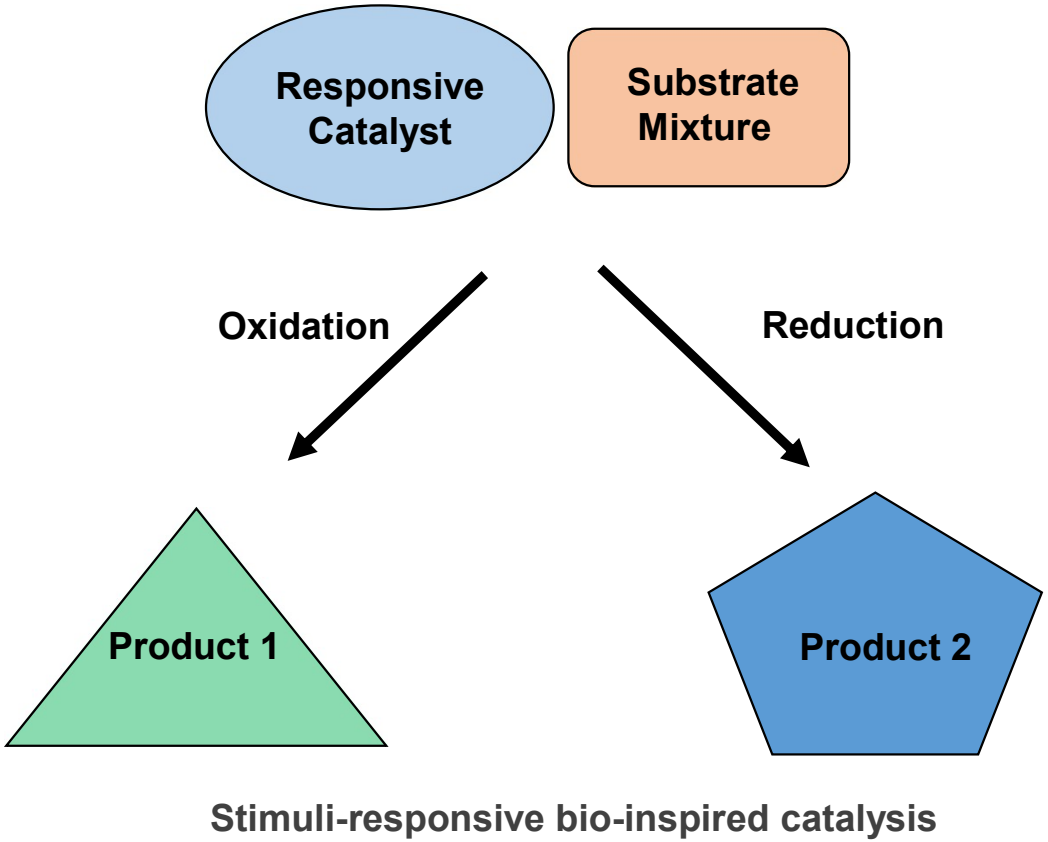
Electrochromism in Smart Windows



Single Molecule Magnets for Data Storage

Picture credits: MIT Research and Sarkar/van Slageren

Relevance of the Topics: Sarkar Group

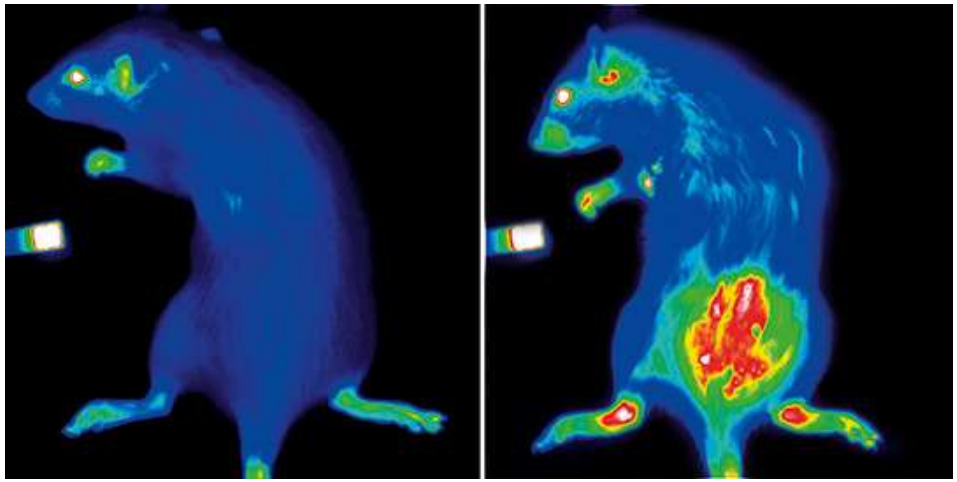


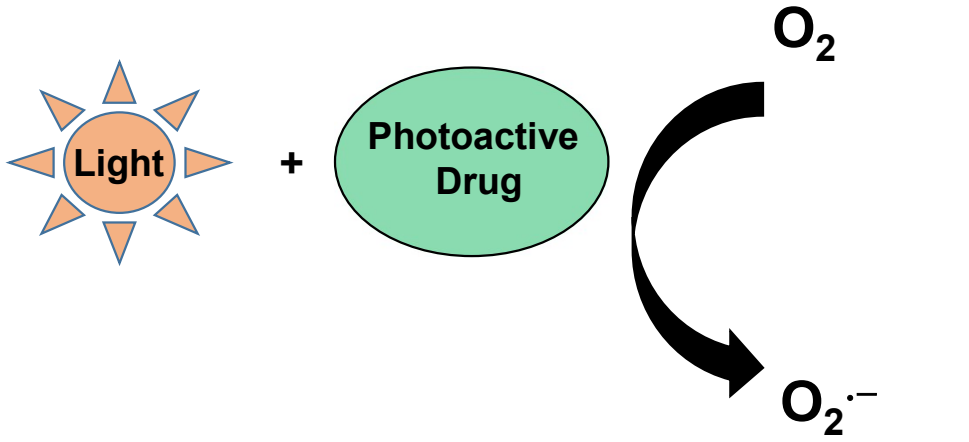
Energy-related research and sustainability:

Reduce CO_2 to CO and proton to H_2 and use as syngas.
Reduce CO_2 to formic acid/oxalic acid/methanol ….

Stimuli-responsive bio-inspired catalysis

Relevance of the Topics: Sarkar Group





Medicinal diagnostics: Imaging

Finding bio-compatible fluorescent markers

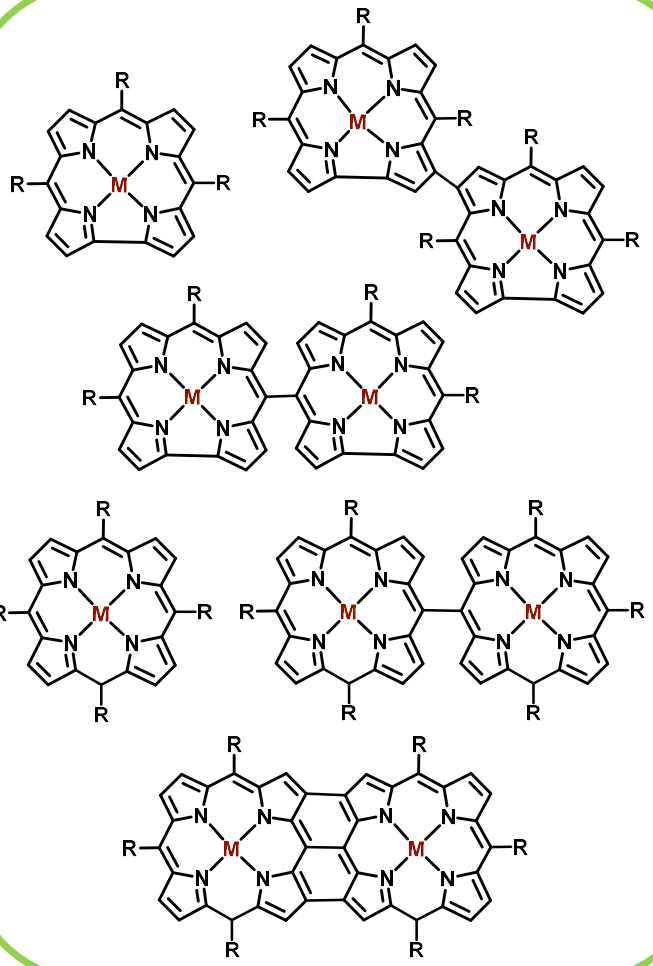
Photo Dynamic Therapy

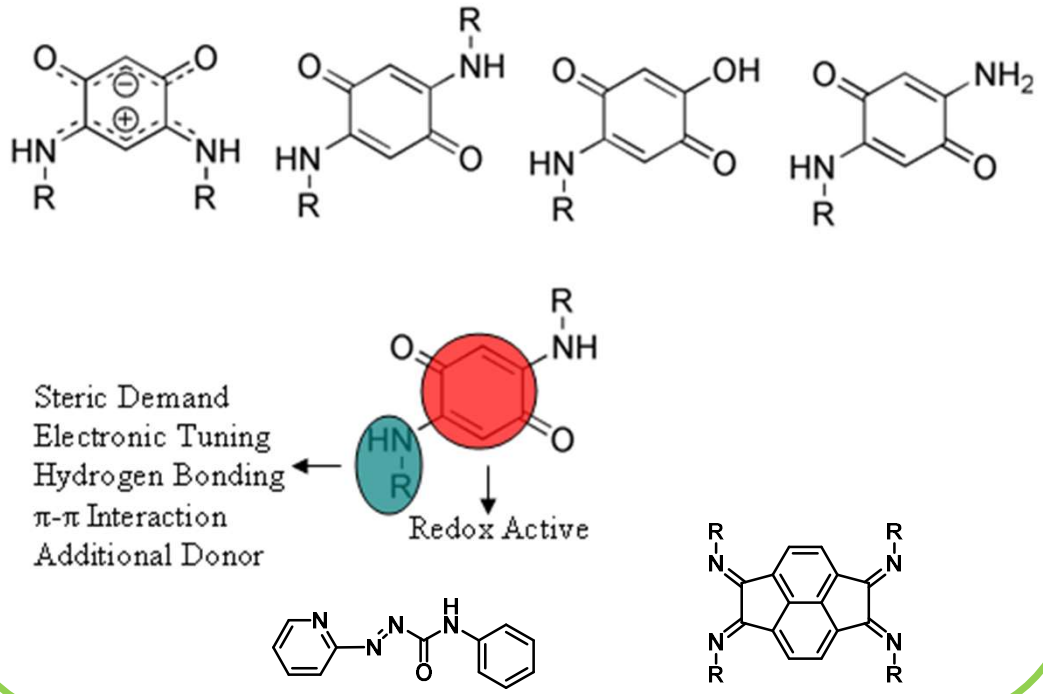
Reactive oxygen species / free radicals
PDT for anti-tumor therapy

Medicinal therapeutics:
Finding „non-toxic“ substitutes for porphyrinoid systems

Image credit: www.kerafest.com

Our Chemical Tools: Redox-Active Ligands (Porphyrins, Corroles, Quinones, Azo)

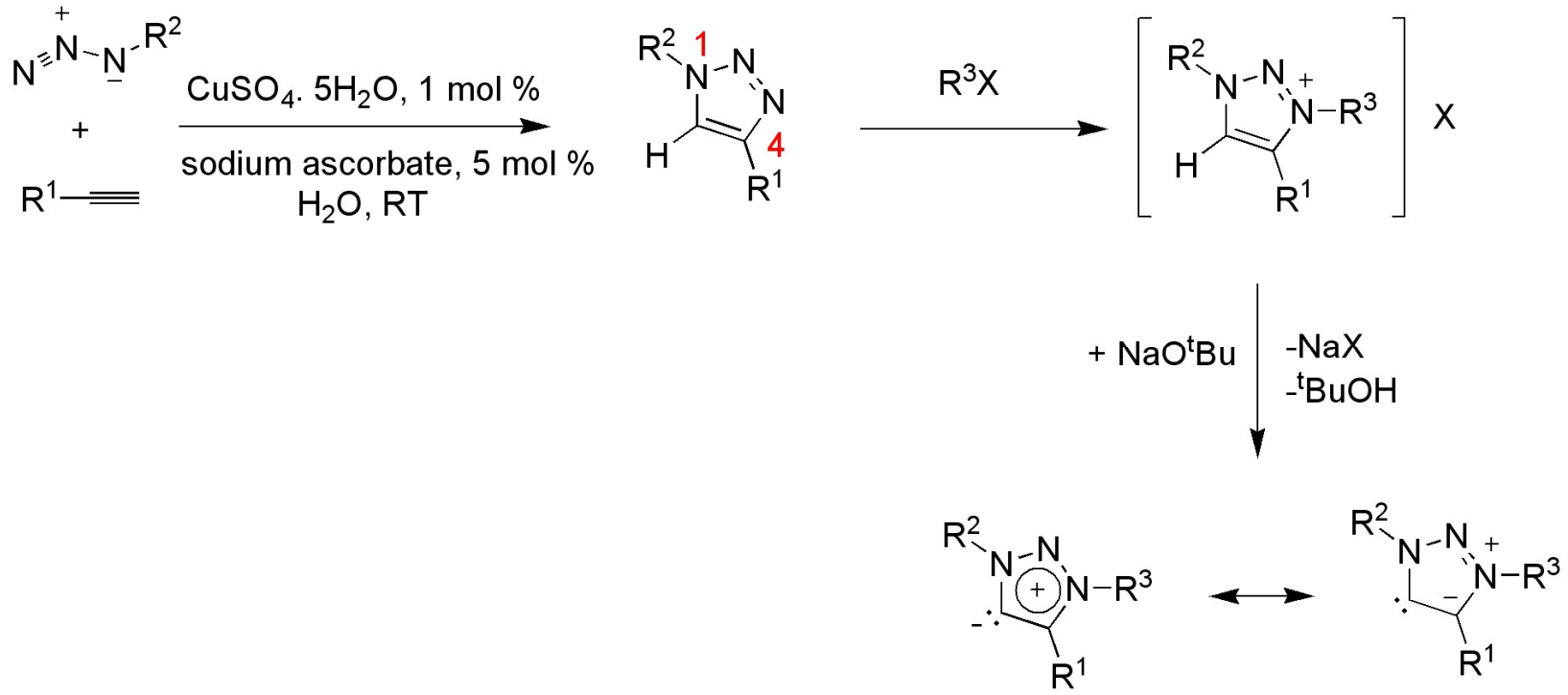




ChemSusChem, (2023), **16**, e202201146
Chem. Eur. J. (2022), **28**, e202104550
Angew. Chem. Int. Ed. (2015), **54**, 13769

Nature Commun, (2024), **in press**
Chem. Sci. (2022), **13**, 10532
Angew. Chem. Int. Ed. (2019), **58**, 9802

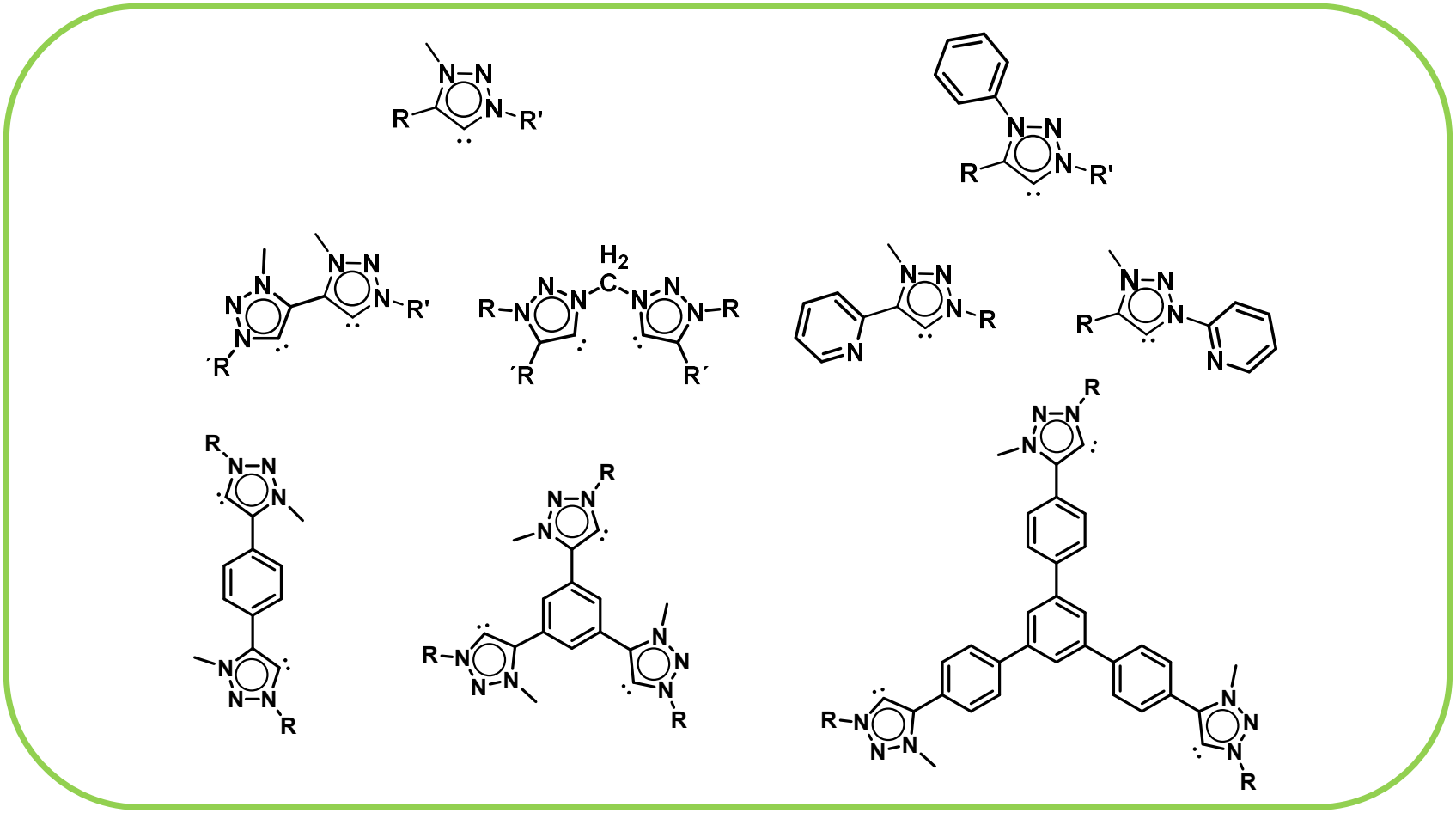
Our Chemical Tools: Mesoionic Carbenes (MIC)



Adaptable Ligands: Carbenes or Carbanions??

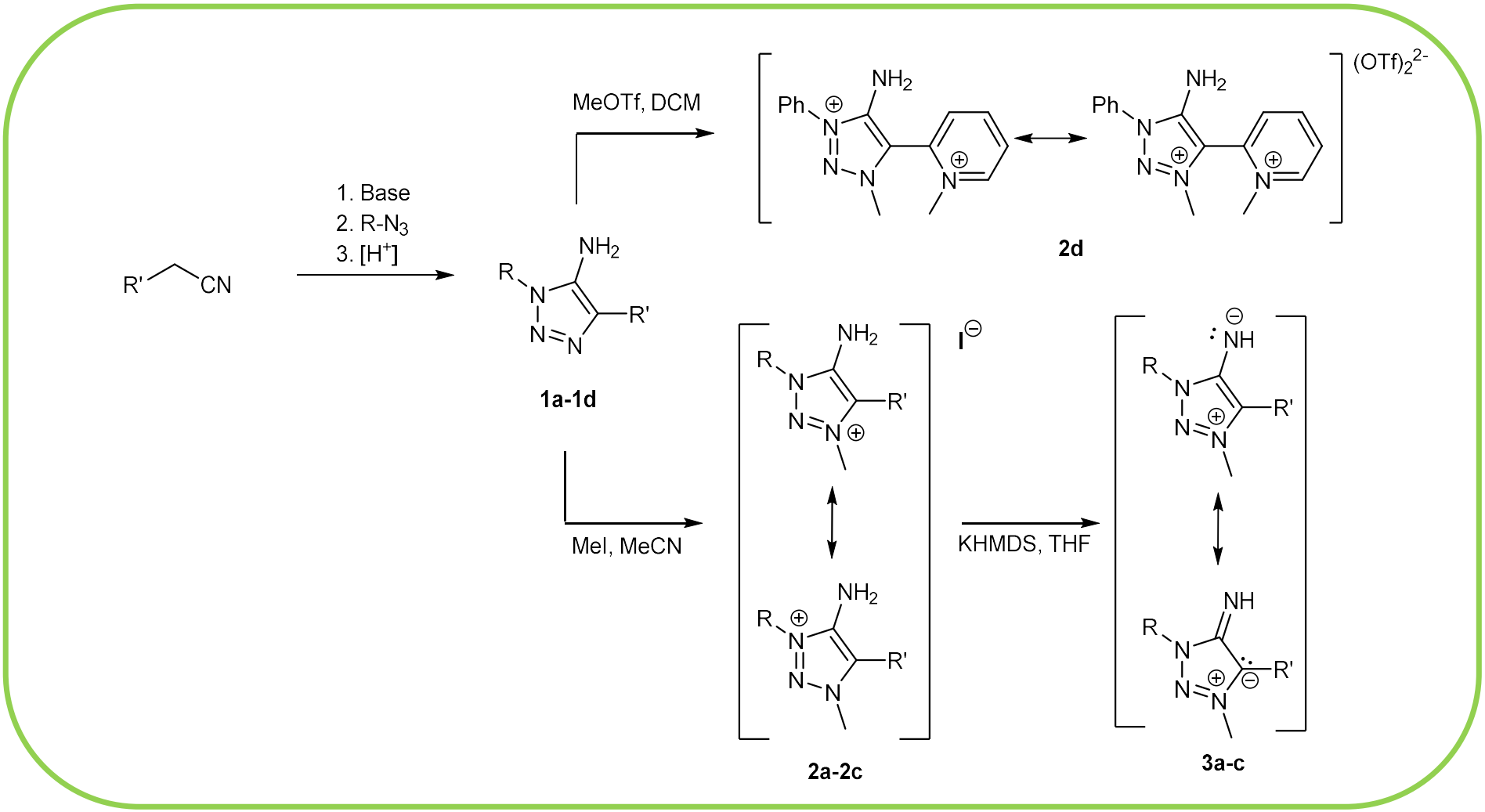
JACS Au (2022), **2**, 22

Our Chemical Tools: Mesoionic Carbenes (MICs)



JACS Au (2022), **2**, 22

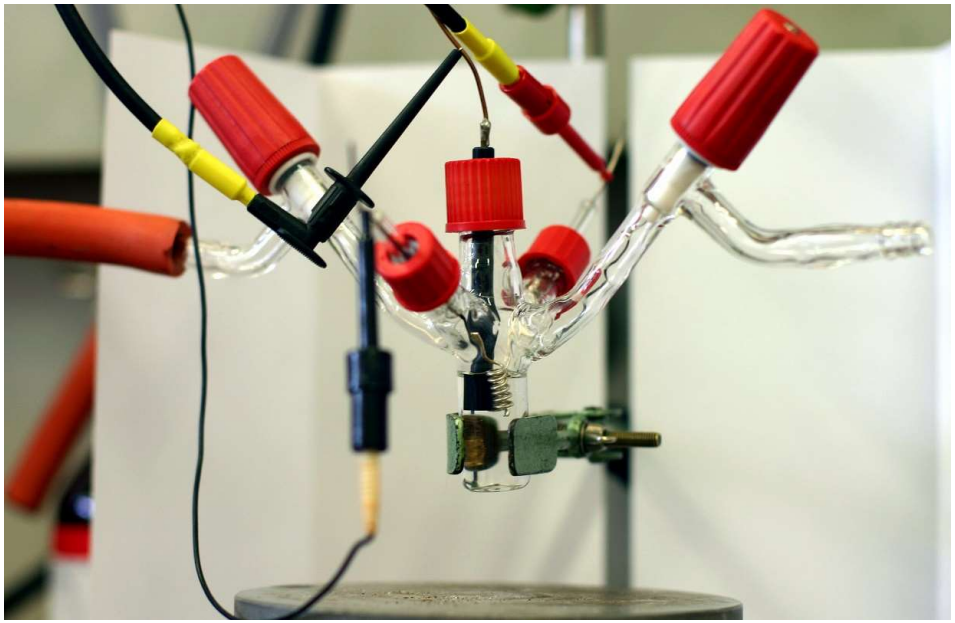
Our Chemical Tools: Mesoionic Imines (MIIs)



Adaptable Ligands: Imines or Amides??

Angew. Chem. Int. Ed. (2022), **61**, e202200653
Chem. Eur. J. (2024), **30**, e202400730

Method Development: Electrochemistry

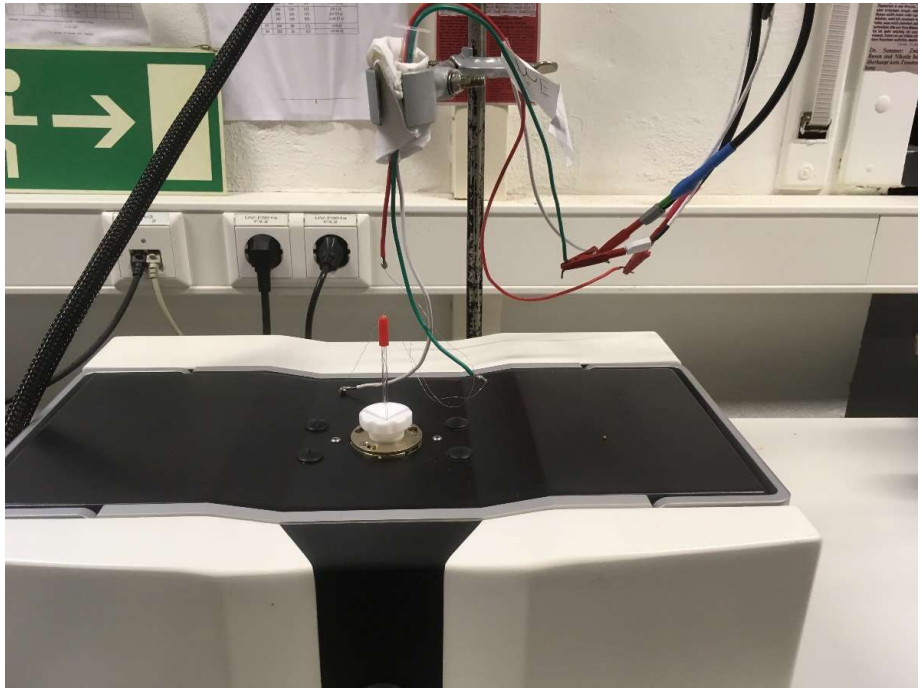


Home-made cyclic voltammetry and bulk-electrolysis cells

Advantages: Modular set-up, measurements with only 1 ml (for CV) solvent possible

Chem. Eur. J. 2017, **23**, 12314

Method Development: EPR Spectroelectrochemistry

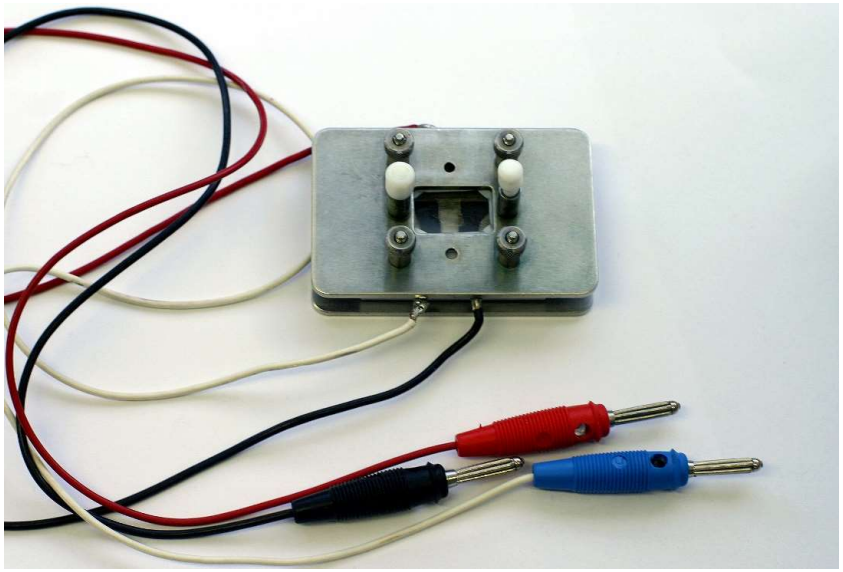


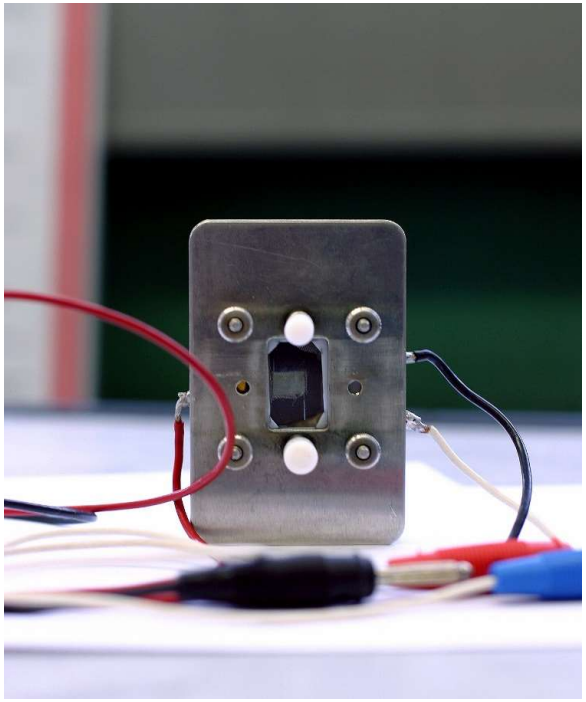
Home-made three-electrode EPR spectroelectrochemistry cell

Advantages:

- **Detection of one/two/three….electron oxidized/reduced paramagnetic species**
- **Mechanistic investigations of electrocatalytic reactions**

Method Development: UV-vis-NIR and IR Spectroelectrochemistry





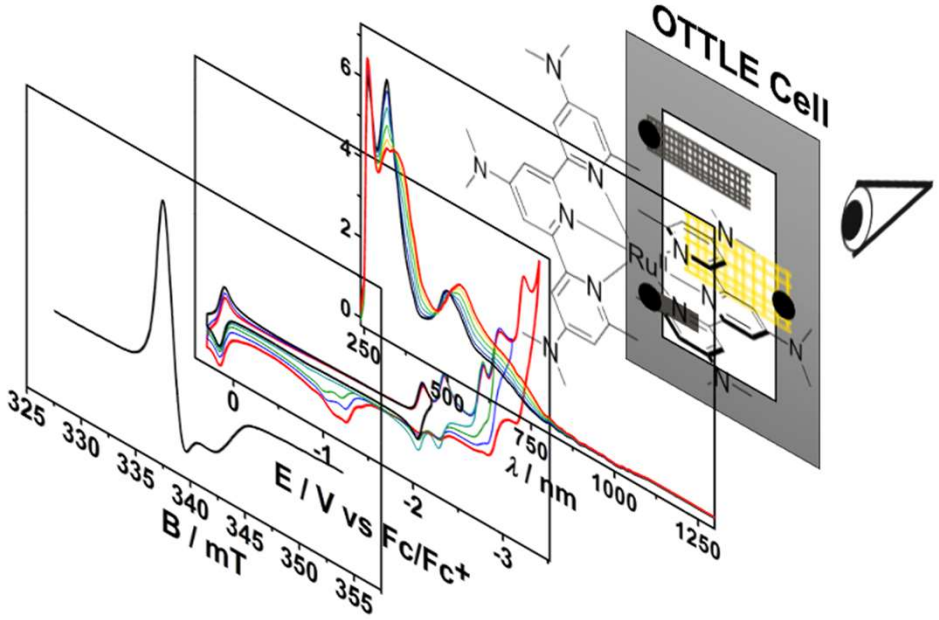
Home-made three-electrode UV-vis-NIR and IR spectroelectrochemistry cell

Advantages:

- **Structural information on all accessible redox states**
- **Mechanistic investigations of electrocatalytic reactions**
- **Spectroscopic signatures of catalytic intermediates**

Chem. Eur. J. 2017, **23**, 12314

Method Development: UV-vis-NIR and IR Spectroelectrochemistry



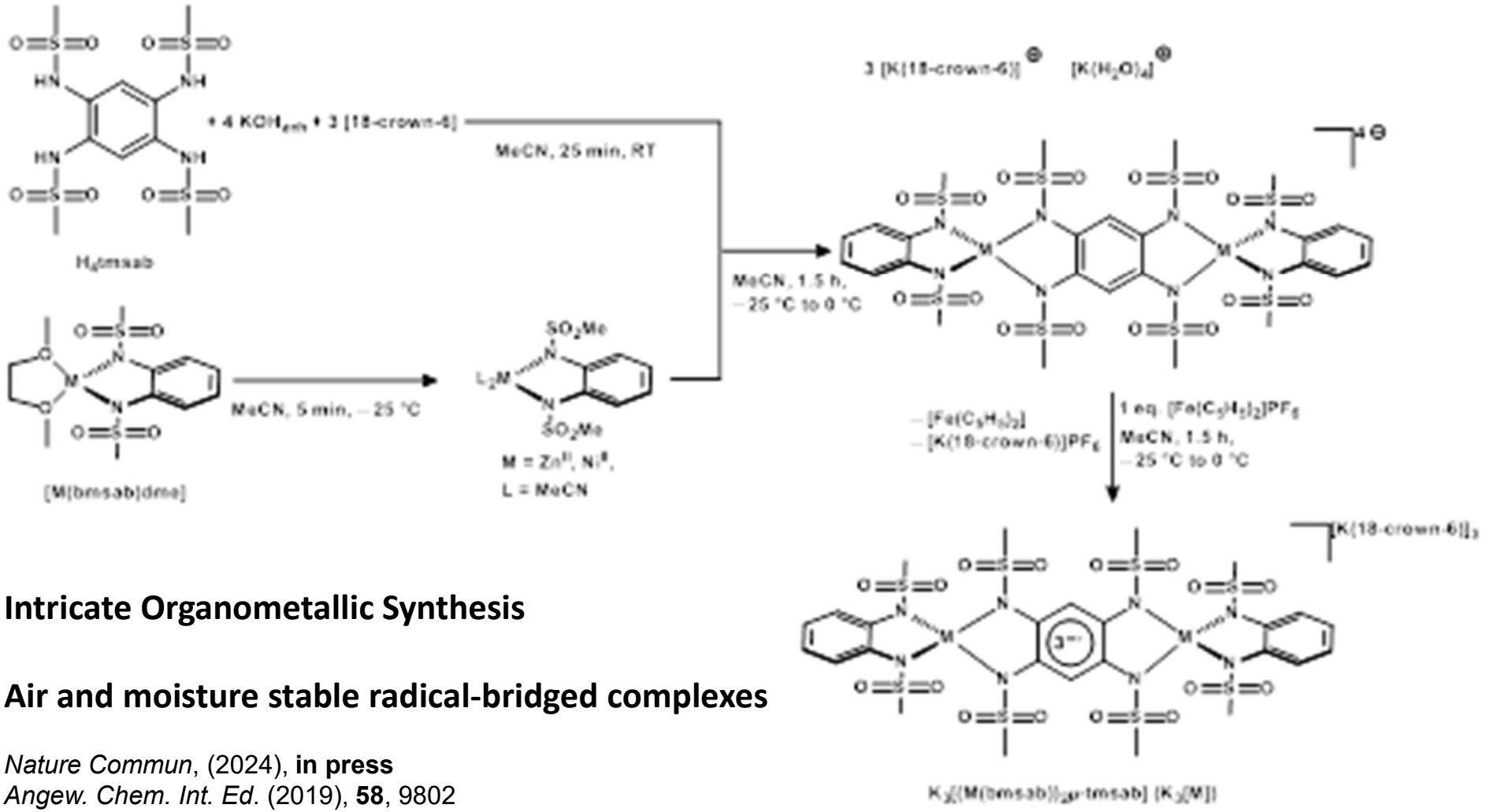
Modular change of the working electrode in the spectroelectrochemical cell

Platinum, glassy carbon, gold….. as working electrodes

Important while investigating electrocatalytic reactions

Chem. Eur. J. 2017, **23**, 12314

State of the Art Single Ion Magnets

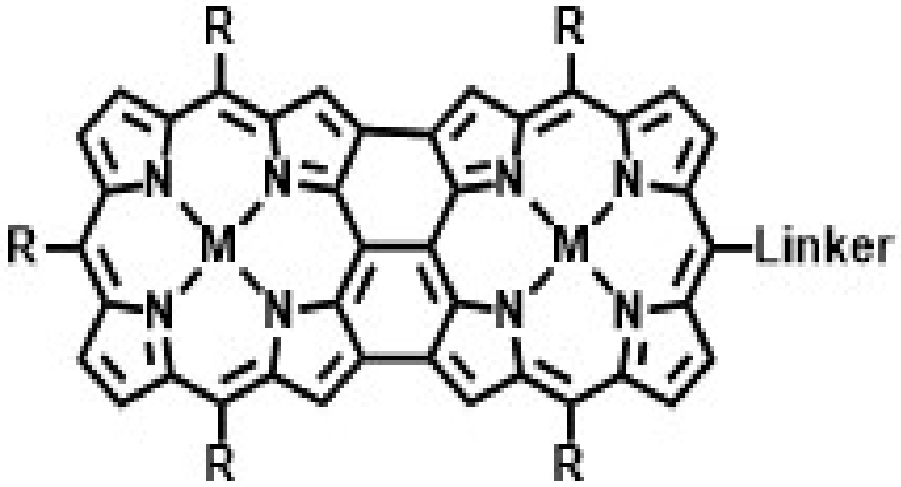


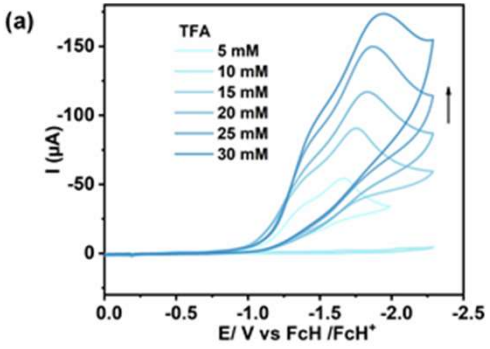
Intricate Organometallic Synthesis

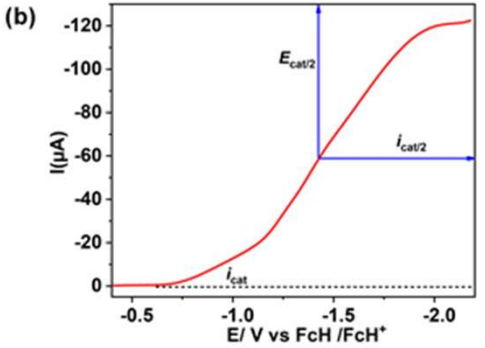
Air and moisture stable radical-bridged complexes

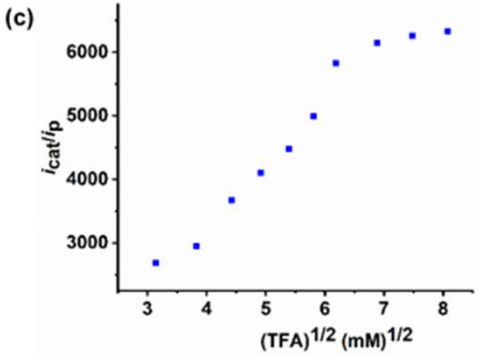
Nature Commun, (2024), **in press**
Angew. Chem. Int. Ed. (2019), **58**, 9802
Nature Commun. (2016), **7**, 10467

Most Efficient Molecular Electrocatalysts for Dihydrogen Production







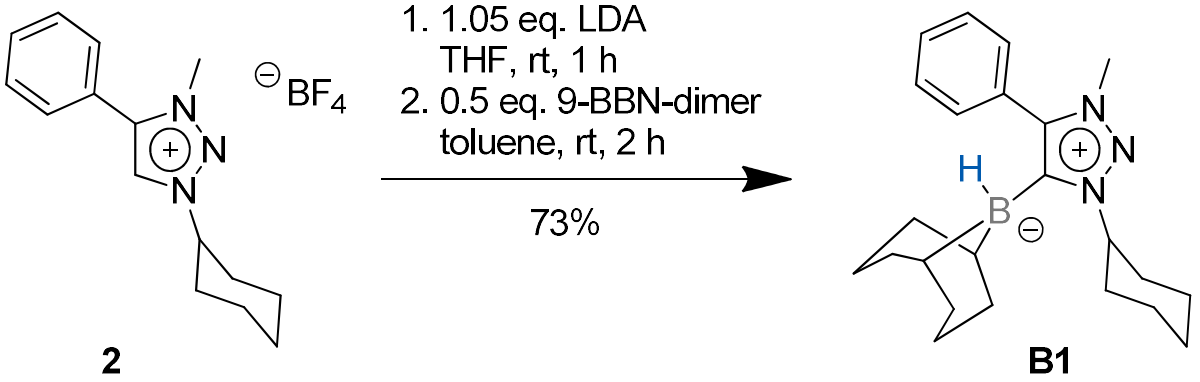


Fused Porphyrins as Privileged Ligands in Electrocatalysis

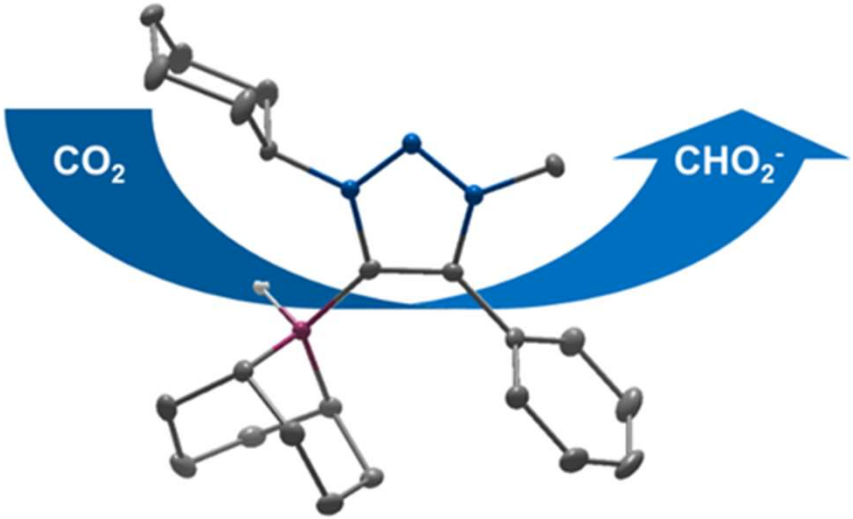
Mechanistic Investigations Through (Spectro)Elecrochemistry

ChemSusChem, (2023), **16**, e202201146
Chem. Eur. J. (2022), **28**, e202104550

Atmospheric CO_2 Capture and Fixation



2 **B1**



Mesoionic Carbenes for CO_2 Capture and Reduction

Simple Metal-free Systems

10.26434/chemrxiv-2024-5w7nc

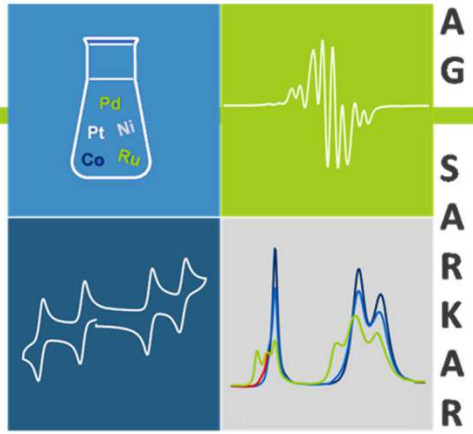
Possible Projects in the Group

We are a group that is involved in the synthesis of electronically adaptable ligand systems (carbenes, imines, non-innocent ligands and so on), and their classical coordination complexes as well as organometallic compounds.

Additionally, we are heavily involved in the use of methods such as:
Multinuclear NMR spectroscopy, single crystal X-ray diffraction, electrochemistry, UV-Vis-NIR- IR- and EPR-spectroelectrochemistry and electrocatalysis.

Possible Topics:

1) **Molecular systems for CO_2 capture and conversion.**
2) **Molecular catalysts for the electrocatalytic conversion of CO_2 and O_2 and for H_2 production.**
3) **Electrocatalysis for organic synthesis.**
4) **Adaptive catalysts for performing redox switchable catalysis.**
5) **Synthesis and characterization of molecules for applications as single molecule magnets and molecular qubits.**
6) **Molecular electrochromic materials.**
7) **Metal complexes as luminiscent probes for bio-orthogonal chemistry.**
8) **Synthesis of electronically ambiguous mesoionic compounds.**
9) **Mechanistic investigations of electrocatalytic reactions with the help of electrochemical and spectroelectrochemical methods.**



Freie Universität Berlin

Large Number of National and International Collaborations

Group Trip: July 2024

First Co-Workers in Berlin: February 2025