Project 2.3 Interfacial photoelectrochemistry for modern organic synthesis – development of transformations based on (photo)-reduction

Supervisor: Prof. Dorota Gryko / Katarzyna Rybicka-Jasińska, PhD
Institute: Institute of Organic Chemistry PAS
www: https://www.icho.edu.pl/zespol/dorota-gryko/katarzyna-rybicka-jasinska/

Background:

In the face of the climate crisis, it is crucial to develop new methods of producing valuable chemical compounds that maximize energy efficiency, atom economy, eliminate toxic waste and reduce the carbon footprint (through the use of renewable sources). The use of photoelectrochemistry is a solution to these problems, as this approach can achieve mild conditions while dramatically reducing the applied current. In interfacial heterogeneous photoelectrochemistry (iPEC), the reaction occurs on the surface of a semiconductor photoelectrode, which, upon activation with visible light, generates an electron-hole pair that is used to drive the redox reaction. While the utility of this approach for solar energy conversion is well known (e.g. for hydrogen production), its benefits for organic synthesis are poorly or unexplored. Therefore, the main goal of this project is to design and apply interfacial, heterogeneous photoelectrochemistry systems for organic synthesis. In the first instance for both anodic oxidation and cathodic reduction in photoelectrochemical (iPEC) systems will be applied for the already developed transformations in single electron transfer chemistry towards improving energy efficiency (proof of the concept). In the next step iPECs systems will be applied towards new modes of activation of organic compounds (developing new C-C and C-X bond forming reactions). Our efforts will establish new photo-supported electrochemically driven methodologies that will expand the synthetic toolbox for organic chemists providing fine chemicals in energy-efficient, green and less-expensive way. Last, but not least it will expand the basic knowledge of electron and energy transfer processes in photoelectrochemistry and iPEC systems, that may in the future will be applied in chemical industry, increasing the atom economy and energy efficiency.

Aim:

In particular, the main tasks will involve:
- Development of electrochemical transformations – model reduction reactions,
- Development of photoelectrochemical transformations – model photoreduction reactions,
- Development of transformations based on the use of photocathodes,
- Study of the scope and limitations of the developed methods,
- Analysis of the literature,
- Preparation of manuscripts and reports.

Requirements:

- a master's degree in chemistry,
- experience in organic or related,
- other skills include analysis and interpretation of experimental data (NMR, MS, UV/Vis),
- demonstrated experience in research work will be an asset,
- effective written and oral communication in English