

## Photoinduced cyclizations for the synthesis of medium-sized (hetero)bicyclic systems

### Abstract

Photochemical reactions in the absence of external (photo)catalyst represent a sustainable approach to the synthesis of complex molecular structures, which would be otherwise difficult to access using classical synthetic methods.

Within this doctoral work, we developed photoinduced transformations of pyrazolo[1,2-*a*]pyrazolones, important biomimetics that absorb visible light. The method enables the selective synthesis of 1,2-diazepines and 5,5,4-tricyclic products simply by changing the irradiation wavelength. The high stereoselectivity of the transformations was rationalized using spectroscopic methods and quantum-mechanical calculations. The reaction can also be performed on a larger scale, both in a flow system and through a one-pot approach starting from azomethine imines. Based on experimental and computational results, a reaction mechanism was proposed in which the diazepine products are formed via triplet biradical intermediates, while the subsequent  $4\pi$ -electrocyclization most likely proceeds synchronously through singlet excited states. The developed transformations thus provide a stereoselective and atom-economical approach to 3D-rich molecular structures.

The methodology was further extended to pyrazolo[1,2-*a*]pyridazinones. A one-pot protocol was developed that prevents the rapid rearrangement of the starting tetrahydropyridazinones. Owing to their absorption of the visible light, pyrazolo[1,2-*a*]pyridazinones can be readily converted into structurally diverse tricyclic, aldehyde, and oxidized products in the absence of external (photo)catalysts. The oxidized products can also be further photoisomerized to form *Z*-isomers.

Given the importance of heterobicyclic systems, we also explored their implementation in photoresponsive systems. Pyrido[1,2-*a*]pyrimidines and their analogues proved to be suitable scaffolds for the design of novel photoswitches. In these systems, optical properties and *Z*-isomer stability can be tuned by varying the molecular structure. The synthesized compounds absorb across a broad region of the visible spectrum and exhibit high fatigue resistance. Two of them also showed partial inhibition of the growth of *Staphylococcus aureus* upon irradiation, indicating the possibility of photoinduced activation and light-controlled biological activity. These results demonstrate that such heterobicyclic scaffolds represent promising platforms for the development of new photoswitches, while a better understanding of the relationship between molecular structure and photophysical properties may facilitate their rational design.