HETEROGENEOUS PHOTOCATALYSIS FOR SUSTAINABLE ORGANIC TRANSFORMATIONS

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The pharmaceutical industry is continually seeking new avenues to develop drugs producing less toxic waste and by-products. Catalysis plays a key role in the chemical sector, where ca. 85% of the manufacturing process involves at least one catalytic step, and not seldom, this is a hydrogenation reaction. Common catalytic hydrogenation methods depend on the use of precious metals, elevated temperatures and high H_2 pressures (or harsh H donors), making the process powerful but unsustainable. Here, I will show our efforts to developing sustainable hydrogenation processes by 1) eliminating the use of harsh conditions and 2) moving towards replacing precious metals.

The use of heterogeneous photocatalysis allows catalytic transfer hydrogenations (CTH) under ambient conditions. Our examples show that high H_2 pressures can be replaced by mild H sources such as solvents. This is, photoexcited holes on semiconductor materials are highly electrophilic and able to activate C–H bonds under mild reaction conditions. Meanwhile, excited electrons can form H from the resulting H^+ leading to H_2 gas generation or (CHT) (Figure 1). Although the reduction step usually relies on the use of precious metals such as Pd or Pt, our work suggests that Co-MoS_2 species bear the potential to substitute these metals. In this presentation, I will discuss our recent developments on the use of heterogeneous photocatalysis in CHT using solvents as H source and the replacement of Pd catalysts by nonprecious Co and Mo elements. Part of the study is centred on the selective semi-hydrogenation of internal and terminal alkynes triggered by Co-MoS_2 structures, and the selectivity of the process is rationalised by studies at the single molecule level. This work constitutes the first steps towards the use of earth-abundant materials for applications in heterogeneous photocatalysis as a promising approach that adds to the easy separation and potential reusability of the catalyst the advantage of developing economically and environmentally friendly methodologies.

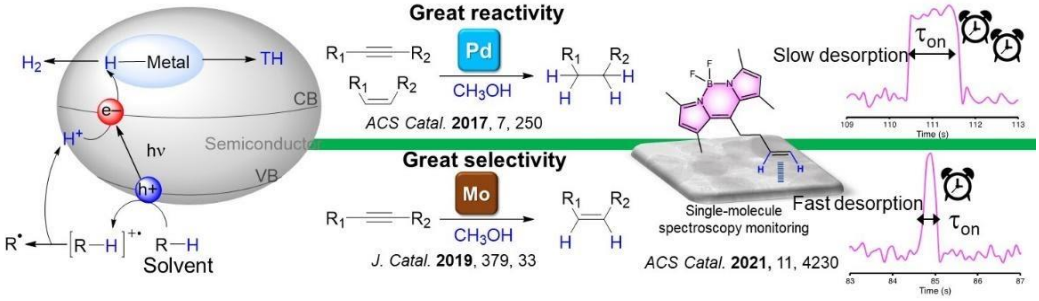

Figure 1. Light-induced catalytic transfer hydrogenation using Pd- and Mo-based co-catalysts.

[1] Work performed at the Scaiano group, University of Ottawa. Co-authors: Bowen Wang, Juan C. Scaiano.