**Green Chemistry and Activation of Small Molecules**

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Green chemistry and syntheses in line with sustainable development are at the center of my research group at University of Helsinki and this presentation provides a brief background on the goals and recent challenges. The core focus of the research is on the catalytic activation of small molecules and thus their utilization in synthesis. Whereas we have extensively studied metal-free hydrogen activation and hydrogenation reactions with frustrated Lewis pairs (FLPs)[1] and aerobic oxidation of alcohols[2], the recent focus has been on efficient methods to activate C-O bonds[3] and use of $CO_2$ as a $C_1$-building block. This opens attractive and sustainable pathways for synthesis of highly valuable pharmaceuticals, chemicals, and materials from which our modern society is depending on. Heterocycles are attractive target compounds. For example, whereas cyclic carbonates are widely used as aprotic polar solvents and synthetic intermediates, 5-membered carbamates (2-oxazolidinones) find their importance in antibiotics. In general, possibility to generate a carbamate anion and use its ability to undergo nucleophilic attack opens a generic approach to synthesis of broad range of biologically active molecules.[4]

Ability to activate small molecules opens also very different applications, including biomass modifications.[5] Mild oxidation reactions open possibility to carry out even dissolution of metals facilitating an interesting green pathway for recycling noble metals, including gold.[6]

References:

1) See for example a) Sumerin, *et al.*, *ACIE* (2008) 6001-6003, b) *JACS* (2008) 14117-14119 c) Chernichenko*, et al*., *Nat. Chem.*, (2013) 718-723. d) Chernichenko, *et al, JACS* (2016), 4860-4868 e) Sorochkina, *Chem. Eur. J.* (2022), 28, e202201927.

2) See for example Cu(II) a ) Figiel *et al., Adv. Synth. Catal.* (2007) 1173-1179. b) Figiel *et al., Ibid* (2009) 2625-2632 c) Cu(I) Lagerspets *et al., Mol. Catal.* (2022) 112167.

3) Watile *et al., Nat. Commun.* (2019) 3826.

4) a) Niemi et.al. Chem. Comm. (2018) 3166—3169. b) Mannisto, *Chem. Eur. J.* (2019), 10284–10289. c) Sahari et al. *Chem. Comm*. (2022) 3027–3030. d) For a review, see: Niemi *et al, Eur. J. Org. Chem*. (2019) 1180–1188.

5) a) Zhang *et al., Green Chemistry* (2021) 5481-5486. b) Zhang et al., Ibid. (2022) 5052-5057. Guo *et al*., Energy & Fuels (2021) 15770-15777.

6) a) Räisänen *et al., ACIE* (2018) 17104-17109. b) Zupanc *et al., ACIE*, (2022) e202117587. Zupanc *et al., ACIE* (2023) e2022144.

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