Transition Metal-Catalyzed, Metal-Free, or Photocatalytic C-C and C-Heteroatom Bond Formation: From Discovery to Mechanistic Insight and Industrial Applications

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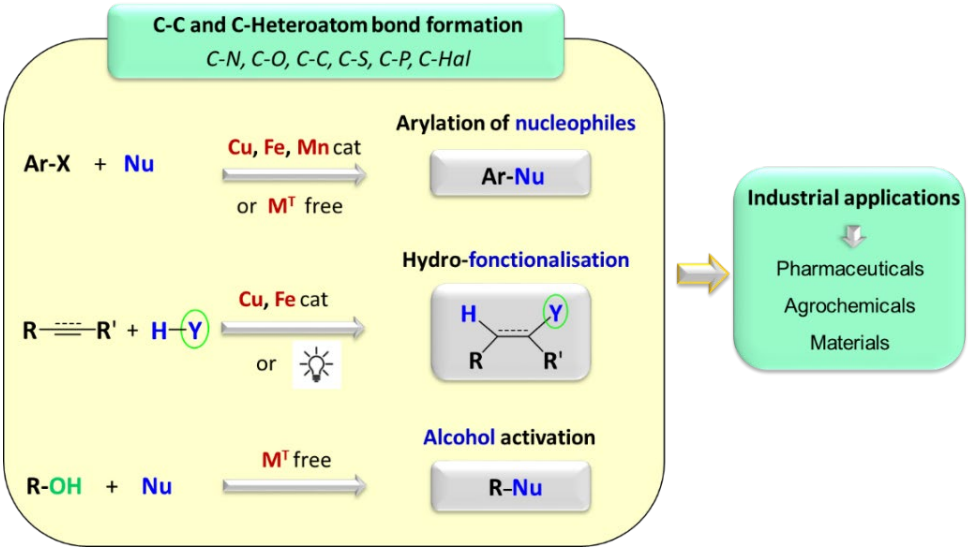
The presentation will focus on methods for the N-, O-, C-, P-, and S-arylation of nucleophiles using aromatic halides, under either transition metal-free conditions or catalytic conditions based on copper, manganese, or iron.[1] These approaches are distinguished by their mild reaction conditions, cost-effectiveness, and operational simplicity, making them particularly attractive for large-scale industrial applications, where both economic and environmental considerations are critical.

Our copper-catalyzed protocols, in particular, have already been adopted by numerous companies worldwide and are expected to make a significant contribution to sustainable synthesis in the years ahead. An industrial application will be presented, together with insights into the reaction mechanisms underlying these transformations.

The talk will also cover recent results on the hydrofunctionalization of unsaturated carbon chains using copper-, iron-, or photochemical activation, as well as a transition metal-free strategy for the functionalization of bio-based alcohols and phenols through selective bond activation.[2]



1.

[1] a) 2001 *Fr 16547* (*WO 03053885*); *Chem. Eur. J.* 2004, 10, 5607; b) *Angew. Chem. Int. Ed.* 2009, 48, 337; c) *Angew. Chem.-Int. Edit.* 2009, 48, 6954; d) *Angew. Chem. Int. Ed.* 2015, *54*, 10587; e) *ACS Catal.* 2017, *7* (7), 4253; f) *Journal of Organic Chemistry* 2019, *84*, 4413; g) *Organic Letters* 2019, *21*, 1564; h) *Journal of Catalysis*, *376*, 2019, 119. j) WO/2025/061989; k) *ACS Catal.* 2025, 15, 9, 7458; l) *Chem.-Asian J.* 2026, 21, e70471.

[2] a) *Chem. Rev.* 2020, 120, 13545; b) *Organic Chemistry Frontiers,* 2021*, 8,* 5112; c) *Journal of Organic Chemistry*, 2021, *86*, 21,15695; d) *Organic Letters*, 2021, *23 (4),* 1484; e) *Chem. Eur. J.*, 2022, 28, e202201495; f) *Journal of Organic Chemistry*, 2023, *88*, 1168. g) *ACS Catal.* 2023, 13, 8624; h) *Org. Chem. Front.* 2024, 11, 775; i) *ACS Org. Inorg. Au* 2025 5, 221-227 ; j) *ChemSusChem* 2025, 18, e202501478; l) *ChemSusChem* 2025, 18, e202401450; k) *Chem.-Eur. J.* 2026, 32, e70795.