

Bismuth Redox Catalysis

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The ability of the main group element bismuth (Bi) to maneuver between different oxidation states in a catalytic redox cycle will be presented. We will show how Bi mimics the canonical organometallic steps of a transition metal, thus challenging the current dogmas of redox catalysis. A series of Bi complexes capable of revolving between oxidation states Bi(I)/Bi(III) and Bi(III)/Bi(V) have been unlocked and applied in various contexts of catalysis for organic synthesis. For example, capitalizing on the Bi(III)/Bi(V) redox pair, we have developed a catalytic protocol for the C–F and C–OTf bond formation from aryl boronic esters. On the other hand, a low-valent redox manifold based on Bi(I)/Bi(III) enabled the reduction of hydrazines and nitro compounds, the catalytic decomposition of the rather inert nitrous oxide (N₂O), the catalytic hydrodefluorination of C(sp²)–F bonds. In addition, we will show how one-electron pathways are also accessible, thus providing a platform for SET processes capitalizing on the triad Bi(I)/Bi(II)/Bi(III) for organic synthesis. Finally, we will also show how redox-neutral catalytic pathways can unlock novel organic transformations via canonical organometallic steps. For all methodologies, a combination of rational ligand design with an in depth analysis of all the catalytic steps proved crucial to unfold the catalytic properties of such an intriguing element of the periodic table.



Josep Cornella was born in south Catalunya. He graduated in chemistry in 2008 from the University of Barcelona and carried MSc studies in the Department of Organic Chemistry studying the chemistry of allylboron reagents. After completing his masters thesis, he moved to the United Kingdom to pursue doctoral studies in the group of Prof. Igor Larrosa (QMUL). In early 2012, he earned his PhD working on the use of aromatic carboxylic acids as aryl donors in metal-catalyzed decarboxylative reactions. He then moved back to Catalunya, where he joined the group of Prof. Ruben Martin (ICIQ) as a Marie Curie Postdoctoral Fellow. There, he developed novel transformations involving Ni-catalyzed C–O bond activation and carbon dioxide insertion into organic molecules. In 2015 he obtained a Beatriu de Pinós Fellowship to carry out further postdoctoral studies in the group of Prof. Phil S. Baran at The Scripps Research Institute, California, USA. During this time at Scripps, he worked on the discovery and implementation of new transformations based on the concept of “redox-active esters” as practical and readily available partners for Ni- and Fe-catalyzed C–C bond forming reactions.

In spring 2017, he was appointed as a Max Planck Group Leader in the Department of Organometallic Chemistry at the Max-Planck-Institut für Kohlenforschung in Mülheim an der Ruhr, Germany. In the same year, he obtained a Max Planck Research Group Leader (MPRGL) position in the same Institute, to create and lead the Sustainable Catalysis Laboratory. His research group focuses on the invention and implementation of basic catalytic alternatives, which secure sustainable and environmentally friendly approaches in organic chemistry. He is an author of more than 60 papers (h-index 30, Scopus), published in the best journals, e.g., Science, Nature, Angew. Chem. Int. Ed., J. Amer. Chem. Soc., Nature Catal. In 2020 he obtained ERC Starting Grant. He has been recognized with several prestigious prizes including Organometallics Distinguished Author Award (2022), Novartis Early Career Award (2021), Kyoto Rising Star Lectureship (MSD Life Science Foundation – Japan, 2021), Heinz Maier-Leibnitz-Preis (Deutsche Forschungsgemeinschaft, 2021), Bayer Early Excellence in Science Award (2020), Otto Röhm Gedächtnisstiftung Forschung Preis (2020).

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