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Editorial

Advances in Transition Metal Catalysis—Preface to the Special Issue

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Over the years, transition metal catalysis has had a significant impact on science and technology. This is due to its role in the development of new highly efficient synthetic processes, where a fine-tuning of the nature of metal-coordinated ligands and counterions allows for many arrays of molecular scaffolds.

Indeed, transition metal-catalyzed processes have enabled the formation of key chemical bonds by controlling important reaction parameters such as selectivity, reactivity, and stability. Today, there is still a great deal of focus on maximizing the chemical usefulness and efficiency of catalyst-driven processes by developing new catalytic materials and investigating new metal-based synthetic methodologies, and significant advances in this field have been raised with scientific activities offering much scope for innovation.

This Special Issue aimed to cover recent progress and trends in the general field of organometallic chemistry with a focus on new catalytic material for specific applications and new catalytic processes for sustainable organic synthesis. Original research papers and short reviews addressing these themes were invited to be contributed, and a brief overview of all papers is presented below.

Contribution 1 describes an efficient gold-catalyzed stereoselective synthesis of *cis*-2,6-disubstituted tetrahydropyrans. This protocol is based on a Meyer–Schuster rearrangement/ hydration/oxa-Michael addition sequence using the readily available bis-propargylic alcohols to start with. In the field of gold catalysis, a mini-review has been provided to focus on an asymmetric hydroarylation reaction as a powerful tool in the construction of useful scaffolds (contribution 2). Switching to different transition metals, a facile Ag(I) protocol for the C4–H amination of 1-naphthylamine with azodicarboxylates has been proposed. The process conveniently takes advantage of the presence of a picolinamide directing group to obtain four aminated 1-naphthylamine derivatives in yields from good to excellent (contribution 3).

Contribution 4 reports on a domino palladium-catalyzed approach leading to the construction of polysubstituted 1,2-dihydro-3*H*-pyrrolo[1,2-a]indol-3-ones by using indol-2-ylmethyl acetates and 1,3-dicarbonyl derivatives; then, contribution 5, provides a comprehensive review of metal-catalyzed A3 coupling methodologies.

Moving on to the area of new catalytic materials, in contribution 6, new Cr/Fe/Mn/Co-based catalysts supported on γ-Al_2O_3 have been prepared and evaluated for industrial applications according to their performance in the ozonation of acetone. Mechanistic insights into the reaction pathways have been provided by in situ DRIFTS measurements. Contribution 7 focuses on CuO/Al_2O_3 catalysts and investigates the importance of the properties of catalytic support for active phase dispersion and speciation and, in turn, for the catalytic performance.

The issue of industrial catalytic methods has also been addressed by some authors who carried out studies with insight into the generality and limits of peculiar processes.

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Citation: Ciogli, A.; Iazzetti, A. Advances in Transition Metal Catalysis—Preface to the Special Issue. *Catalysts* **2024**, *14*, 438. https://doi.org/10.3390/catal14070438

Received: 3 July 2024
Accepted: 4 July 2024
Published: 9 July 2024

In this regard, the Fischer–Tropsch synthesis, commonly used for the conversion of a synthesis gas mixture containing carbon monoxide and hydrogen (syngas) into liquid hydrocarbon, has been investigated in contribution 8. Particularly, the authors used density functional theory (DFT) calculations to investigate the reaction mechanism over the catalyst surface, namely Co (001). The findings reveal the mechanisms underlying the creation of CH_4, CH_3OH, and C_2H_2 molecules, with calculations indicating that CH_4 is the major product.

Contribution 9 reports on the catalytic etching and oxidation of platinum group metals by studying the morphology, chemical composition, and structure of the catalytic materials under O_2 and during the NH_3 oxidation process performed with air at 1133 K. The results of this study revealed that the exothermic reaction of NH_3 with oxygen on metals and PdO or Rh_2O_3 determine an intense catalytic etching process, leading to the formation of grains and facets on Pt, fibrous metal oxide agglomerates, pyramidal crystals, and metallic "cauliflowers" on Rh and Pd.

To study the potential use of bimetallic iron–silver systems supported on mordenite for catalysis and adsorption, the impact of the order of components deposition on the formation of silver species has been explored (contribution 10).

Finally, contribution 11 presents a comprehensive overview of the significant progress achieved using ionic liquids and deep eutectic solvents in developing nickel-based electrocatalysts.

Overall, the scientific contributions in this Special Issue have provided significant insights into the newest perspectives of transition metal catalysis, illustrating the progress made and the additional efforts needed in this research area.

Compiling this Special Issue presented a challenging task for us, and we wish to extend our sincere thanks to the MDPI Editorial Board and *Catalysts* for allowing us to serve as Guest Editors. We also express our gratitude to the Assistant Editor and the Section Managing Editor, Patty Ge, for their invaluable assistance. Finally, we are thankful to all the authors who dedicated their time and their work to contribute to this opus and hope that the readers found this Special Issue useful for their future research activities, envisaging an intriguing range of challenges and opportunity in this field.

Author Contributions: Writing—original draft preparation, A.I.; writing—review and editing, A.C.; All authors have read and agreed to the published version of the manuscript.

Acknowledgments: We gratefully acknowledge the Catholic University of the Sacred Heart—Campus of Rome and the Sapienza University of Rome.

Conflicts of Interest: The authors declare no conflicts of interest.

List of Contributions

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