

Green Catalytic Formation of Alcohols, Amines, Amides, Imines and Esters under Mild Conditions (Yeda)

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Summary

A novel set of manganese, ruthenium and related borohydride complexes (Pincer-type) were developed as remarkably efficient and environmentally-benign catalysts for the synthesis of alcohols, amines, amides, imines and esters, which are the basic building blocks for the research, chemicals, pharmaceutical and agrochemical industries. In addition, a catalytic carbon-carbon bond formation using non-activated aliphatic nitriles and carbonyl compounds was achieved with the manganese complex. These reactions are conducted under mild and neutral conditions, using low catalyst loading, require no hydrogen acceptors or oxidants, employ no corrosive or toxic reagents and generate no waste. Moreover, manganese is one of the most abundant transition metals on earth crust, making it appealing and biocompatible when considering a system for eventual scale-up and industrial use. In view of global concerns regarding economy, environment and sustainable energy resources, there is an urgent need for the discovery of new catalytic reactions. These newly developed catalysts address key problems of current traditional synthetic methodologies, both from the economic and the environmental aspects.

Applications

Pharmaceuticals Dyes Cosmetics and fragrances Fibers Agrochemicals


Advantages

Cost-effective in terms of reagents, reactions conditions (low temperature and pressure) and waste treatment (green reactions). New synthetic pathways that were not possible before, such as the synthesis of amides and imines directly from alcohols and amines, esters synthesis from alcohols and methanol synthesis from CO₂ and hydrogen. Broad substrate scope. Excellent yields.

Technology's Essence

Prof. David Milstein's group has discovered a new mode of action for metal-ligand cooperation, involving aromatization-dearomatization of ligands. Pincer-type, pyridine-based complexes of Mn, Ir, Rh, Ru, Pd, Pt and acridine complexes of Ru have been shown to exhibit such cooperation, leading to facile activation of C-H, C-C, H-H, N-H, O-H bonds, and to novel, environmentally friendly reactions catalyzed by Mn and Ru.

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