Design and Applications of Sustainable Catalytic Reactions for Synthesis and Energy

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The design of ”green” synthetic methodology and new approaches to sustainable energy are major goals of modern catalysis. Traditionally, catalysis by metal complexes has been based on the reactivity of the metal center, while the ligands bound to it influence its reactivity, but do not interact directly with the substrate. In a major advance in homogeneous catalysis, complexes based on “cooperating” ligands were developed, in which both the metal and a ligand undergo bond making and breaking in key steps of the catalytic cycle, thus providing exciting opportunities for catalytic design.

We have developed a new mode of metal-ligand cooperation, involving ligand aromatization – dearomatization, which provides a new approach to the activation of chemical bonds. Pincer-type complexes of several transition metals exhibit such cooperation, including complexes of Ru, Fe, Co, Rh, Ir, Ni, Pd, Pt, Mn and Re. This has led to fundamentally new, environmentally benign catalytic reactions, including several reactions which either produce dihydrogen or consume it. Synthetic and energy-relaed applications based on these reactions will be described.

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