

【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Chemistry)



Title of Project : Activation and Synthetic Transformation of Stable Chemical Bonds by Cooperative Metal Catalysis

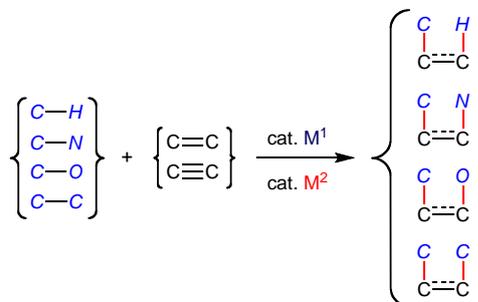
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Research Area : Chemistry

Keyword : Complex/Organometallic catalysis

【Purpose and Background of the Research】

Organic synthesis has been playing essential roles in invention of novel pharmaceuticals, agrochemicals, and materials, which are all indispensable for present and future human life. However, there still remain many problems to be solved for realization of truly safe, efficient, and environmentally benign organic synthesis. To maintain sustainable human society in the future, it is essential to disclose conceptually novel reactions and minimize wastes produced by conventional organic reactions, most of which require prefunctionalization of organic molecules and, thus, are accompanied by byproduct formation in tremendous amounts through multi-step procedures. Synthetic reactions involving activation of C–H, C–C, C–N, and C–O bonds, which are ubiquitous in many organic compounds, should be of great potential in view of atom economy. Activation of these stable chemical bonds by conventional organometallic catalysis is not necessarily easy to realize. In this research project, we propose a new strategy to realize the activation of such stable chemical bonds and their catalytic transformations to construct new C–C, C–N, and C–O bonds by cooperative catalysis by different organometallic complexes.



【Research Methods】

We have recently developed hydroheteroarylation, hydrocarbamoylation, and carbocyanation reactions across alkynes through activation of stable C–H and C–CN bonds by nickel/Lewis acid (LA) cooperative catalysis. Considering the importance of alkenes as substrates in the present

chemical industry, the corresponding alkene functionalization will be pursued in this research project. Based on the findings during the research, we will also pursue new strategies to activate stable and strain-free C–H, C–C, C–N, and C–O bonds by transition metal/LA cooperative catalysis to realize aminocyanation, alkoxylation, carboacylation, carboamidation, aminoamidation, and alkoxyamidation reactions across unsaturated bonds.

【Expected Research Achievements and Scientific Significance】

Organic synthesis has advanced significantly by invention of new reactions. Recent typical examples are cross-coupling reactions and olefin metathesis, that have brought innovations to retro-synthesis of target molecules, allowing direct C–C bond formation at C(sp²) carbon and new efficient synthesis of macrocycles. The transformations to be invented in this project are definitely unprecedented and thus will have such innovative utility in organic synthesis to be applicable to environmentally benign synthesis of pharmaceuticals, agrochemicals, and various organic materials in both laboratory and industrial scale.

【Publications Relevant to the Project】

- “A Dramatic Effect of Lewis Acid Catalyst on Nickel-catalyzed Carbocyanation of Alkynes” Nakao, Y.; Yada, A.; Ebata, S.; Hiyama, T. *J. Am. Chem. Soc.* **2007**, *129*, 2428–2429.
- “A Strategy for C–H Activation of Pyridines: Direct C-2 Selective Alkenylation of Pyridines by Nickel/Lewis-acid Catalysis” Nakao, Y.; Kanyiva, S. K.; Hiyama, T. *J. Am. Chem. Soc.* **2008**, *130*, 2448–2449.

【Term of Project】 FY2009-2013

【Budget Allocation】 164,100 Thousand Yen

【Homepage Address and Other Contact Information】

<http://npc05.kuic.kyoto-u.ac.jp/e-index.htm>