Academic Program [Oral B] | 10. Organic Chemistry -Organometallic Compounds-：Oral B

Wed. Mar 26, 2025 1:00 PM - 3:10 PM JST | Wed. Mar 26, 2025 4:00 AM - 6:10 AM UTC
[F]2102(2102, Bldg. 2, Area 4 [1F])

[[F]2102-1pm] 10. Organic Chemistry -Organometallic Compounds-

Chair: Yoichi Hoshimoto, Masakazu Nambo

Japanese
1:00 PM - 1:20 PM JST | 4:00 AM - 4:20 AM UTC
[[F]2102-1pm-01]

Palladium-catalyzed annulation reaction of 2-quinolinecarboxamides via C-H/N-H sequential functionalization

○Shoichi Sugita[1], Kentaro Okano[2], Atsunori Mori[2,1] (1. Research Center for Membrane and Film Technology, Kobe University, 2. Department of Chemical Science and Engineering, Kobe University)

English
1:20 PM - 1:40 PM JST | 4:20 AM - 4:40 AM UTC
[[F]2102-1pm-02]

Pd-catalyzed enantioselective allylation of acyclic fluoroenolate

○Taiki Negoro[1], Sensuke Ogoshi[1], Yoichi Hoshimoto[1], Ryohei Doi[1] (1. Osaka University)

Japanese
1:40 PM - 2:00 PM JST | 4:40 AM - 5:00 AM UTC
[[F]2102-1pm-03]

Development of Virtual Ligand-Assisted Optimization Method for In Silico Ligand Engineering and Its Application to Hydrogermylation of Terminal Ynamide

○Wataru Matsuoka[1,2,3], Taihei Oki[2,3], Ren Yamada[1], Tomohiko Yokoyama[4], Shinichi Suda[1], Carla M. Saunders[5], Bastian Bjerkem Skjelstad[6], Yu Harabuchi[2,3], Natalie Fey[5], Satoru Iwata[4,2,3], Satoshi Maeda[1,2,3] (1. Hokkaido University, 2. WPI-ICReDD, 3. JST-ERATO, 4. The Univ. of Tokyo, 5. University of Bristol, 6. University of Oxford)

2:00 PM - 2:10 PM JST | 5:00 AM - 5:10 AM UTC

Break

English
2:10 PM - 2:30 PM JST | 5:10 AM - 5:30 AM UTC
[[F]2102-1pm-04]

Ni-catalyzed Cross-Coupling Reactions of Aryl Sulfones

○Ryusei Ohkura[1], Yasuyo Tezuka, Yokogawa Daisuke[3], Masakazu Nambo[1], Cathleen Crudden[1,2] (1. Nagoya University, 2. Queen's University, 3. The Univ. of Tokyo)

English
2:30 PM - 2:50 PM JST | 5:30 AM - 5:50 AM UTC
[[F]2102-1pm-05]

Nickel-Catalyzed Synthesis of Silaindanes via Sequential C–H Activating 1,5-Nickel Migration and C–Si Activating 1,4-Nickel Migration

○Donghyeon Lee[1], Ikuya Fujii[1], Ryo Shintani[1] (1. Osaka University)

English
2:50 PM - 3:10 PM JST | 5:50 AM - 6:10 AM UTC

[[F]2102-1pm-06]

Monodentate Borane Ligands for Square-Planar Nickel(0) Complexes

〇Yutaka Mondori[1], Yasuhiro Yamauchi[1], Sensuke Ogoshi[1], Yuta Uetake[1,2], Hidehiro Sakurai[1,2], Yoichi Hoshimoto[1,3] (1. Osaka University, 2. ICS-OTRI, Osaka Univ., 3. CFi, Division of Applied Chemistry, Faculty of Engineering, Osaka Univ.)

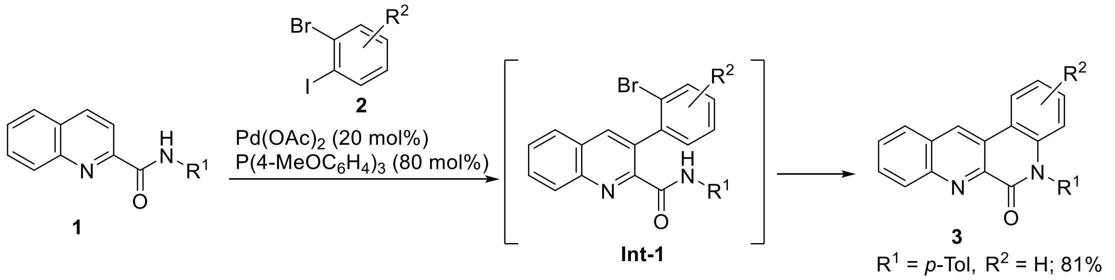
Palladium-Catalyzed Annulation Reaction of 2-Quinolinecarboxamides via C-H/N-H Sequential Functionalization

([1]*Research Center for Membrane and Film Technology, Kobe University*, [2]*Department of Chemical Science and Engineering, Kobe University*) ○Shoichi Sugita,[1] Kentaro Okano,[2] Atsunori Mori[1,2]

Keywords: Quinoline; Palladium catalyst; C-H activation; Sequential reaction; C-N coupling

The cyclic structures involving heterocycles are extremely important because the heterocycle-fused cyclic structures are found in various advanced materials[1] and biologically essential molecules.[2] The direct C-H arylation reaction serves as a useful method for molecular transformation. On the other hand, the carbocyclic intermolecular C-H/N-H activation reaction of carboxamides is possible to synthesize annulation product directly,[3] although this type of reaction with π-deficient *N*-heterocycle has not been reported. We previously reported intramolecular C-H arylation reaction of π-deficient *N*-heterocycles which is notable method to provide cyclized products.[4] According to this result, we envisioned the intermolecular annulation reaction of 2-quinolinecarboxamide for the C-H/N-H sequential functionalization reaction in the presence of palladium catalyst.

The reaction proceeded at the C-H bond on the quinoline adjacent to the amide group and amide N-H bond of the compound **1** in the presence of 20 mol% of $Pd(OAc)_2$ with $P(4\text{-}MeOC_6H_4)_3$ in *o*-xylene as a solvent to afford the cyclized product **3** with 1-iodo-2-bromobenzene **2** in 81% yield. The quinoline containing amide moiety **1** also achieved the C-H/N-H sequential functionalization in up to 83% yield with various amide functional group and substituted 1-iodo-2-bromobenzenes **2**. Furthermore, this reaction with 2,3-dibromo heteroarene such as benzothiophene and pyridine was also carried out to give the corresponding heterocycle-fused compounds. The high positional selectivity of the functional group bearing 1,2-dihaloarenes has also been confirmed to the annulation reaction.



R^1 = *p*-Tol, R^2 = H; 81%
and up to 83% with
various substrates

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Pd-catalyzed enantioselective allylation of acyclic fluoroenolate

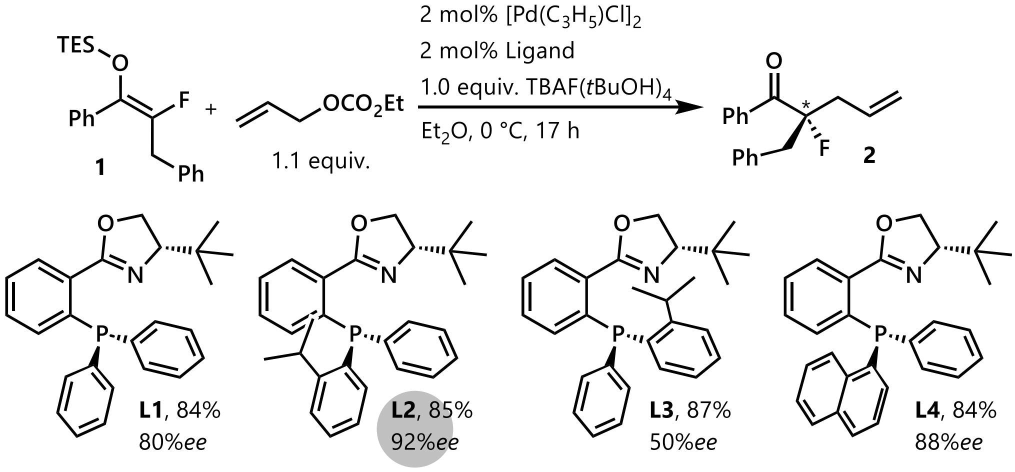
(*[1]Faculty of Engineering, Osaka University, [2] Center for Future Innovation (CFi), Faculty of Engineering, Osaka University*) ○Taiki Negoro,[1] Sensuke Ogoshi,[1] Yoichi Hoshimoto,[1,2] Ryohei Doi[1]

Keywords: *Asymmetric reaction; Tsuji-Trost reaction; DFT calculation; P-chiral phosphine; Pd catalyst*

Fluorine-containing tertiary stereogenic centers are attractive scaffolds in medicinal chemistry.[1] The asymmetric allylation of fluoroenolate is a valuable approach for constructing a stereogenic center. Despite the enantioselective allylation of cyclic fluoroenolate has been achieved, acyclic version remains challenging.[2]

We recently reported a nickel-catalyzed cross-coupling reaction of difluoroenolate with organozinc reagent to give an acyclic silyl fluoroenolate (**1**).[3] In this study, we developed the enantioselective allylation of our acyclic silyl fluoroenolate using a Pd catalyst.

In the presence of catalytic amounts of $[Pd(C_3H_5)Cl]_2$ and (*S*)-*t*BuPHOX (**L1**), and a stoichiometric amount of TBAF·(*t*BuOH)$_4$ as the silyl activator, the reaction of allyl carbonate with our silyl fluoroenolate **1** afforded the desired product in 85% yield with 80% enantiomeric excess (*ee*). To improve enantioselectivity, we synthesized a series of P-chiral PHOX ligands, of which single-crystal X-ray diffraction studies confirmed absolute configurations. As a result, among the ligands, the ligand **L2** gave **2** in higher *ee* than **L1**.



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[2] Z. Li, L. Fan, G. Liu *Org. Biomol. Chem.* **2024**, *22*, 4592.

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バーチャル配位子法を用いたインシリコ配位子設計法の開発と末端イナミドのヒドロゲルミル化反応への応用

(北大 WPI-ICReDD[1]・JST-ERATO[2]・北大院理[3]・北大院総化[4]・東大情報理工[5]・ブリストル大[6]・オックスフォード大[7]) ○松岡 和[1,2,3]・大城 泰平[1,2]・山田 蓮[4]・横山 智彦[5]・須田 真一[4]・Carla M. Saunders[6]・Bastian Bjerkem Skjelstad[7]・原渕 祐[1,2]・岩田 覚[1,2,5]・前田 理[1,2,3]

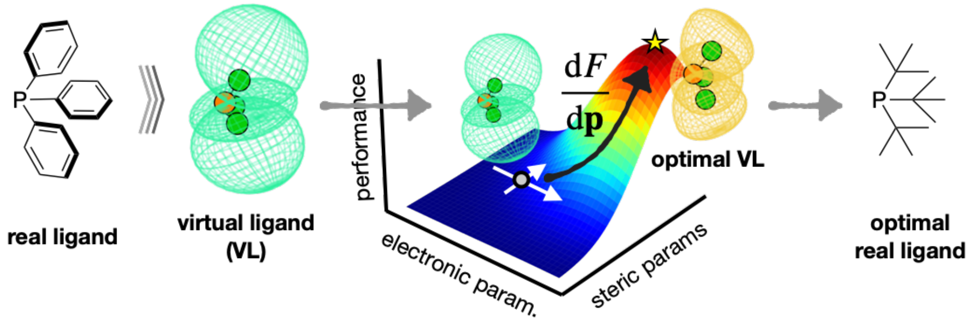
Development of Virtual Ligand-Assisted Optimization Method for *In Silico* Ligand Engineering and Its Application to Hydrogermylation of Terminal Ynamide

([1]*WPI-ICReDD, Hokkaido University,* [2]*JST-ERATO,* [3]*Faculty of Science, Hokkaido University,* [4]*Graduate School of Chemical Sciences and Engineering, Hokkaido University,* [5]*Graduate School of Information Science and Technology, The University of Tokyo,* [6]*University of Bristol,* [7]*University of Oxford*) ○ Wataru Matsuoka,[1,2,3] Taihei Oki,[1,2] Ren Yamada,[4] Tomohiko Yokoyama,[5] Shinichi Suda,[4] Carla M. Saunders,[6] Bastian Bjerkem Skjelstad,[7] Yu Harabuchi,[1,2] Satoru Iwata,[1,2,5] Satoshi Maeda[1,2,3]

Ligand engineering is one of the most important, but labor-intensive processes in the development of transition metal catalysis. Herein, we report the virtual ligand-assisted optimization (VLAO) method, a fundamentally new *in silico* approach for ligand engineering. In this method, the virtual ligand, a dummy ligand for quantum chemical calculations, is used to identify important electronic and steric features for ligand engineering. We demonstrated the VLAO calculation for the α-selective hydrogermylation of a terminal ynamide, and ideal ligand features were automatically identified. In the presentation, the theory behind the VLAO method will be briefly explained, followed by the results of its application to actual ligand design.

Keywords : In Silico Catalyst Optimization; Virtual Ligand; Quantum Chemical Calculation

遷移金属触媒の設計には、多数の配位子候補からいかに効率的に最適配位子を選択できるかが極めて重要である。我々は、量子化学計算と簡単な数学的操作により目的の反応に最適な触媒の特徴を見出すバーチャル配位子アシスト最適化(VLAO)法を開発した。本手法をもとに量子化学計算に基づいて触媒設計指針を定めることで、迅速かつ合理的に最適触媒を見出すことが可能である。発表では VLAO 法の詳細と末端イナミドのヒドロゲルミル化反応に適用した結果を述べる。



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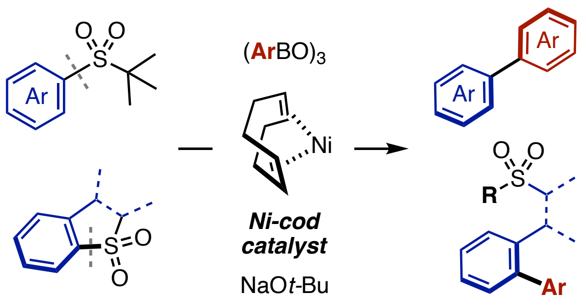
Ni-catalyzed Cross-Coupling Reactions of Aryl Sulfones

([1]Department of Chemistry, Graduate School of Science, Nagoya University [2]Institute of Transformative Bio-Molecules (WPI-ITbM), Nagoya University, [3] Graduate School of Arts and Sciences, The University of Tokyo, [4]Department of Chemistry, Queen's University) ○Ryusei Ohkura[1], Yasuyo Tahara[2], Daisuke Yokogawa[3], Masakazu Nambo[1,2], and Cathleen M. Crudden[2,4]

Keywords: Ni catalysis, Sulfone, Suzuki–Miyaura cross-coupling, C–SO_2 bond activation, Sulfinate

Over the last decade, organosulfones have increasingly attracted attention as a valuable class of electrophiles in cross-coupling due to their ease of handling, bench-stability, and functional group tolerance. Arising from the pioneering work by Wenkert, various types of desulfonylative cross-coupling reactions of sulfones have been developed.[1] Our group has developed transition-metal-catalyzed desulfonylative cross-coupling reactions of alkyl or aryl sulfones with organometallic reagents to construct highly functionalized sp^3 carbon centers in a modular manner. In the case of Suzuki–Miyaura type cross-coupling of aryl sulfones for biaryl synthesis, Moran, and Yorimitsu reported Pd-, and Pd/Rh-catalyzed systems.[2]

This presentation details a new Ni-catalyzed Suzuki–Miyaura cross-coupling of simple aryl sulfones with arylboroxines through carbon–sulfonyl (C–SO_2) bond activation. The utilization of the sulfonyl moiety as electron-withdrawing and directing groups provides a highly functionalized products via regioselective and iterative transformations, which are difficult to achieve with typical leaving groups. Moreover, cyclic arylsulfones can be employed in the ring-opening cross-coupling followed by a trapping with various electrophiles, producing π-conjugated structures bearing useful sulfur-containing functional groups. In contrast to a typical Ni-phosphine catalyst, this Ni-cod catalyst preferentially reacts with aryl sulfone over aryl chloride. And the sodium sulfinate released during C–SO_2 bond cleavage exhibits an unexpected rate-accelerating effect, as supported by mechanistic studies based on control experiments and DFT calculations.



- *Unusual ligand effect*
  cod: ArSO$_2$*t*-Bu > ArCl
  PPh$_3$: ArCl >> ArSO$_2$*t*-Bu
- *Reaction rate acceleration by released sulfinate*
- DFT calulation
  low activation energy in C–SO$_2$ bond cleavage by sulfinate

1) a) M. Nambo, Y. Maekawa, C. M. Crudden, *ACS Catal*. **2022**, *12*, 3013.

2) a) P. Chatelain, A. Sau, C. N. Rowley, J. Moran, *Angew. Chem., Int. Ed.* **2019**, *58*, 14959. b) Fukuda, J.; Nogi, K.; Yorimitsu, H. *Org. Lett*. **2019**, *21*, 8987.

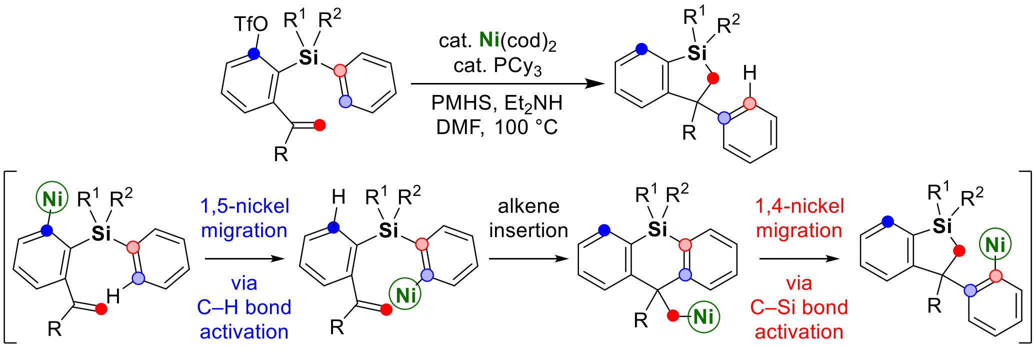
C–H 活性化を伴う 1,5-ニッケル転位および C–Si 活性化を伴う 1,4-ニッケル転位を経由する触媒的シラインダンの合成

（阪大院基礎工）○Lee Donghyeon・藤井 郁哉・新谷 亮
Nickel-Catalyzed Synthesis of Silaindanes via Sequential C–H Activating 1,5-Nickel Migration and C–Si Activating 1,4-Nickel Migration (*Graduate School of Engineering Science, Osaka University*) ○Donghyeon Lee, Ikuya Fujii, Ryo Shintani

Catalytic reactions involving 1,*n*-metal migration provide a powerful strategy for constructing complex molecular skeletons from simple precursors.[1] In this work, a nickel-catalyzed synthesis of 3,3-disubstituted 1-silaindanes, silicon analogues of valuable indanes, was developed by utilizing 1,5-nickel migration via C–H bond activation and 1,4-nickel migration via C–Si bond activation.[2] The detailed mechanism was investigated by conducting deuterium labeling experiments and DFT calculations. This research demonstrates the potential of 1,*n*-nickel migration processes through C–H and C–Si bond activation, offering a powerful tool for efficient synthesis of useful cyclic organosilicon compounds.

Keywords : Nickel Catalyst; Organosilicon Compound; C–H Bond Activation; C–Si Bond Activation; Metal Migration Reaction

1,*n*-金属転位を経る遷移金属触媒反応は、簡単な出発物質から複雑な分子構造を構築する上で有用なプロセスである[1]。本研究では、これまでに報告例のない C–H 結合の活性化を伴う 1,5-ニッケル転位および C–Si 結合の活性化を伴う 1,4-ニッケル転位を組み合わせた新規反応を開発し、インダン類のケイ素等価体である 3,3-二置換 1-シラインダンの触媒的合成に成功した[2]。本反応では、1,5-ニッケル転位によって遠隔位の C–H 結合の活性化が可能となるだけでなく、続くアルケン挿入の位置選択性も制御できる。さらに、重水素化実験および DFT 計算により、各転位段階の反応機構を明らかにした。本研究で得られた結果は、1,*n*-ニッケル転位を経る触媒反応が含ケイ素環状化合物を合成する上で有用な手法となることを示すものである。



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[2] Lee, D.; Fujii, I.; Shintani, R. *ACS Catal.* **2025**, *15*, 907.

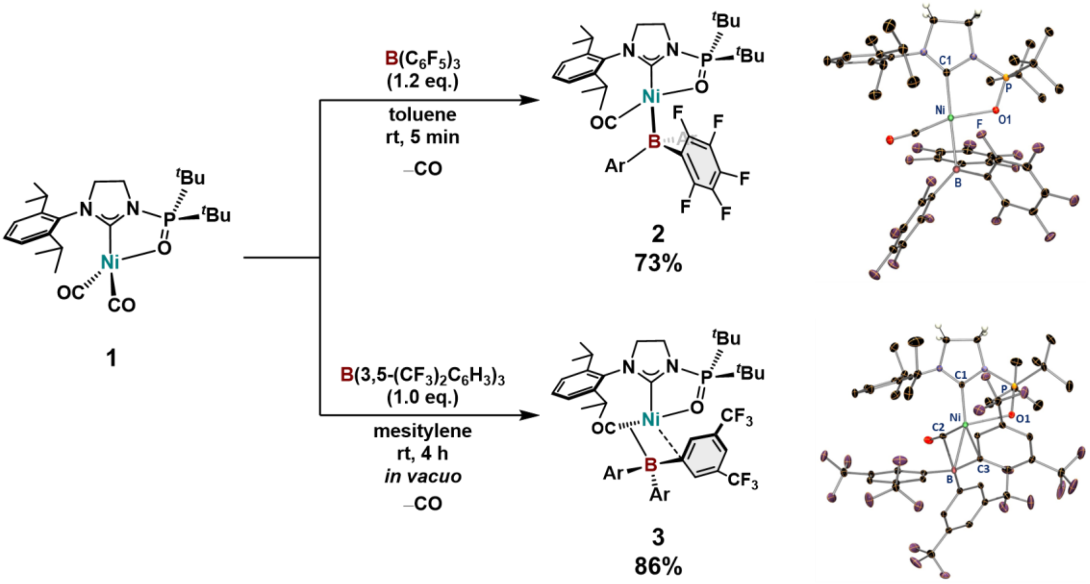
Monodentate Borane Ligands for Square-Planar Nickel(0) Complexes

([1]*Faculty of Engineering, Osaka University*, [2]*ICS-OTRI, Osaka University*, [3]*Center for Future Innovation (CFi), Faculty of Engineering, Osaka University*) ○Yutaka Mondori,[1] Yasuhiro Yamauchi,[1] Sensuke Ogoshi,[1] Yuta Uetake,[1,2] Hidehiro Sakurai,[1,2] Yoichi Hoshimoto[1,3]

Keywords: *Nickel complex; Z-type ligand; N-Heterocyclic carbene; Borane*

Transition metals are known to work as electron donors toward electron-accepting heavier-group-13 elements (Al, Ga, and In), called Z-type ligands.[1-4] However, complexes with boron-based monodentate Z-type ligands have never been reported.[2] Herein, we report the synthesis of Ni(0) complexes that bear *N*-phosphine-oxide-substituted imidazolinylidenes (SPoxIms)[5] and boranes as a monodentate Z-type ligand.

Reaction of **1** with $B(C_6F_5)_3$ yielded a square-planar nickel(0) complex (**2**) including $Ni–B(C_6F_5)_3$ bond with dissociation of CO. On the other hand, $B(3,5-(CF_3)_2C_6H_3)_3$ without the *ortho*-F atoms in *B*-aryl group afforded a tetrahedral Ni(0) complex (**3**) via Ni–CO bond coordination to the boron atoms. In this work, a combined theoretical and experimental approach revealed a mixed covalent/dative character for the Ni–B bonds.



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