

平成 31 年 4 月 8 日現在

機関番号：11301
 研究種目：基盤研究(C) (一般)
 研究期間：2016～2018
 課題番号：16K05680
 研究課題名(和文) プレンステッド塩基触媒による環化付加反応を用いた複素環化合物の新規合成法の開発

研究課題名(英文) Development of New Method for Synthesis of Heterocyclic Compounds Utilizing Cycloaddition Reactions Catalyzed by Bronsted Base

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交付決定額(研究期間全体)：(直接経費) 3,800,000円

研究成果の概要(和文)：本研究では、多置換五員複素環化合物の新たな立体選択的合成法の確立を目的として、独自に考案したプレンステッド塩基触媒による三員環化合物の環拡大の方法論を用いて、三員環化合物と不飽和化合物の形式的[3+2]環化付加反応の開発に取り組んだ。その結果、不斉有機超強塩基キラルビス(グアニジノ)イミノホスホランを触媒として用いることで、エポキシドとイミンの形式的不斉[3+2]環化付加反応が高立体選択的に進行することを見いだした。本反応の生成物である光学活性1,3-オキサゾリジン、光学活性アミノアルコールへの変換をはじめとする種々の分子変換が可能であり、キラルビルディングブロックとして有用である。

研究成果の学術的意義や社会的意義

本研究では、三員環化合物と不飽和化合物の形式的不斉[3+2]環化付加反応に初めてプレンステッド塩基触媒を適用することに成功した。この成果は光学活性五員複素環化合物の合成における新たな方法論を提供するものである。五員複素環化合物の遍在性および有機合成におけるビルディングブロックとしての有用性を鑑みると、複雑化合物の合成戦略に新たな指針を与えるものとして、大きな意義がある。また、プレンステッド塩基を用いる触媒的分子変換の新たな可能性を示した点でも意義がある。

研究成果の概要(英文)：With the aim of establishing the novel synthetic methods of multi-substituted five-membered heterocyclic compounds in a highly stereoselective manner, we investigated the formal [3+2] cycloaddition reactions of three-membered ring compounds, such as epoxides, aziridines, and cyclopropanes, with unsaturated compounds on the basis of our original methodology utilizing Bronsted base catalysis. As a result, we successfully developed a novel enantioselective formal [3+2] cycloaddition reaction of , -epoxysulfones with imines under Bronsted base catalysis. The chiral bis(guanidino)iminophosphorane as a chiral organosuperbase catalyst enabled the enantioselective reaction, owing to its strong basicity and high stereocontrolling ability, to provide enantioenriched 1,3-oxazolidines, which are useful building blocks in organic synthesis, in a highly diastereo- and enantioselective manner.

研究分野：有機合成化学

キーワード：有機塩基触媒 不斉触媒反応 環化付加反応 複素間骨格構築 付加反応 アセタール合成 不斉合成

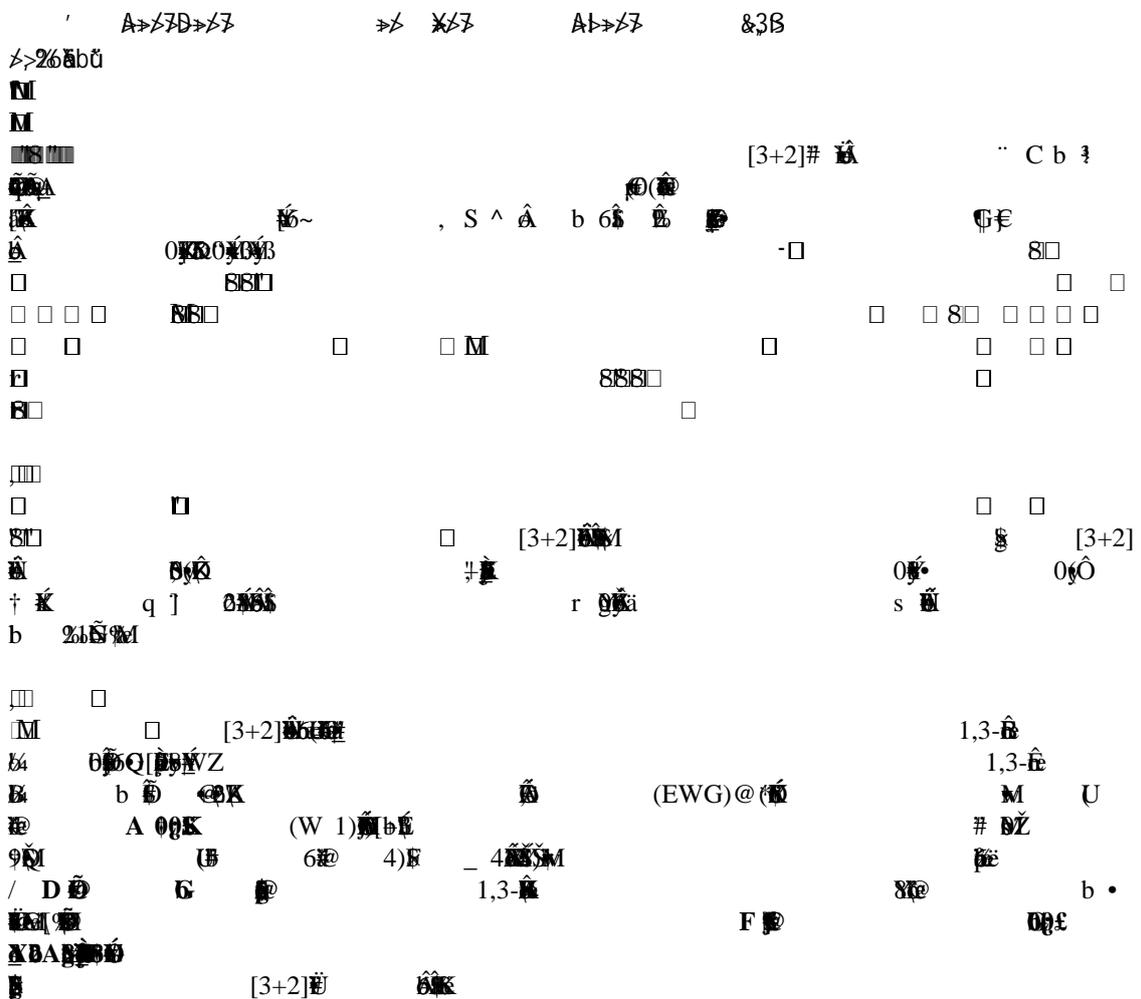


图1

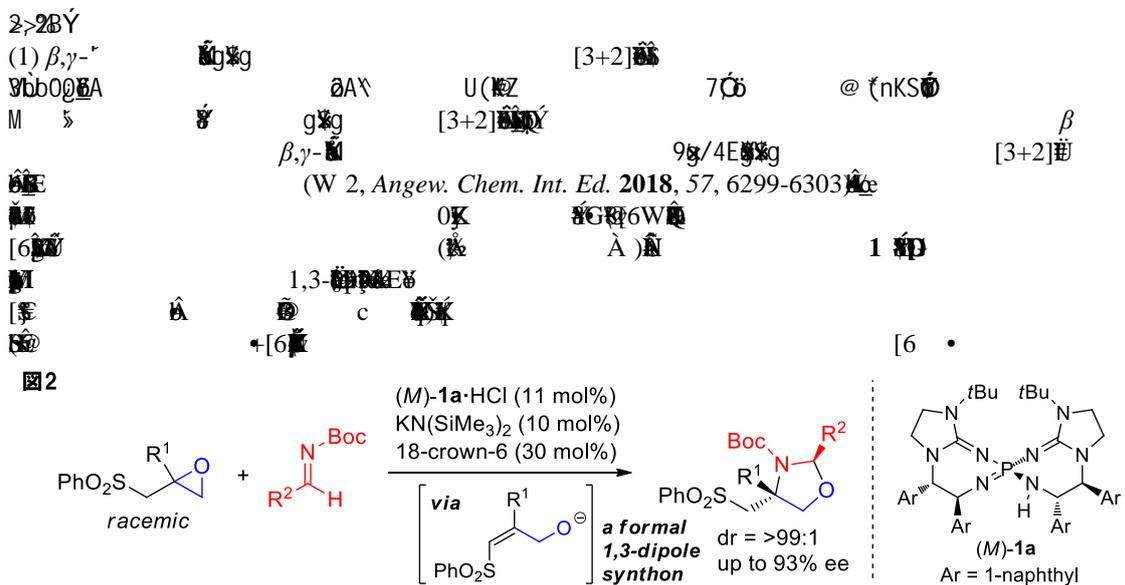
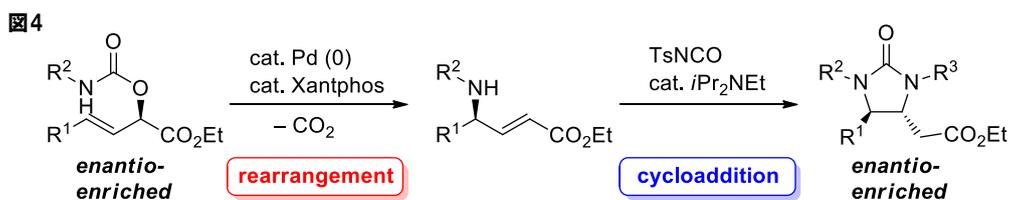
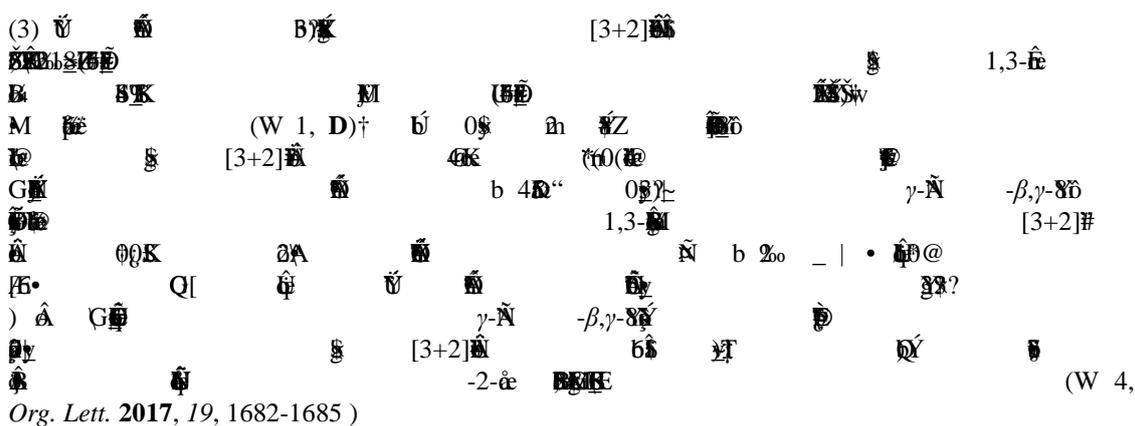
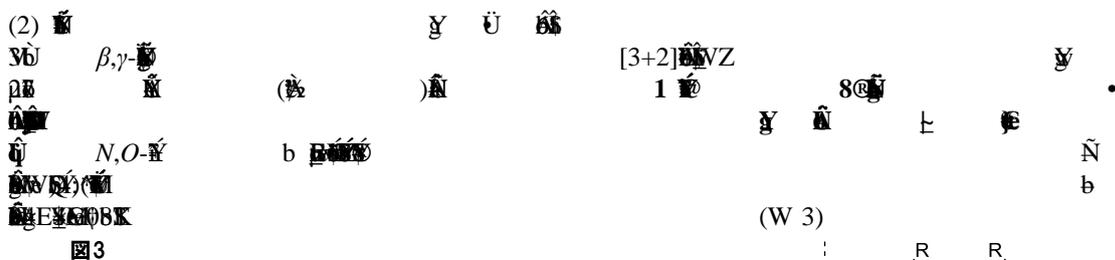


图2



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- [Azusa Kondoh](#), Akio Iino, Sho Ishikawa, Takuma Aoki, Masahiro Terada, Efficient Synthesis of Polysubstituted Pyrroles Based on [3+2] Cycloaddition Strategy Utilizing [1,2]-Phospha-Brook Rearrangement under Brønsted Base Catalysis, *Chemistry - A European Journal*, 1w , 24 s , 2018, 15246-15253. DOI: 10.1002/chem.201803809
 - r [Azusa Kondoh](#), Masahiro Terada, Brønsted Base-Catalyzed Reductive Cyclization of α,β -Unsaturated Iminoesters through Auto-Tandem Catalysis, *Organic Letters*, 1w , 20 s , 2018, 5309-5313. DOI: 10.1021/acs.orglett.8b02236
 - s [Azusa Kondoh](#), Takuma Aoki, Masahiro Terada, Organocatalytic Arylation of α,β -Unsaturated Ketoesters Based on Umpolung Strategy: Phosphazene-Catalyzed S_NAr Reaction Utilizing [1,2]-Phospha-Brook Rearrangement, *Chemistry - A European Journal*, 1 w , 24 s , 2018, 13110-13113. DOI: 10.1002/chem.201803218
 - t [Azusa Kondoh](#), Shiori Akahira, Masafumi Oishi, Masahiro Terada, Enantioselective Formal [3+2] Cycloaddition of Epoxides with Imines under Brønsted Base Catalysis: Synthesis of 1,3-Oxazolidines with Quaternary Stereogenic Center, *Angewandte Chemie International Edition*, 1w , 2018, 57 s , 6299-6303. DOI: 10.1002/anie.201802468
 - u [Azusa Kondoh](#), Masahiro Terada, Phospha-Brook-Catalyzed Umpolung Intramolecular Cyclization of Alkynyl Imines, *Chemistry - A European Journal*, 1w , 24 s , 2018, 3998-4001. DOI: 10.1002/chem.201800219
 - v [Azusa Kondoh](#), Ryosuke Ozawa, Takuma Aoki, Masahiro Terada, Intramolecular Addition of Benzyl Anion to Alkyne Utilizing [1,2]-Phospha-Brook Rearrangement

- Base Catalysis, *Organic & Biomolecular Chemistry*, 1w , 2017, 15 s , 7277-7281.
DOI: 10.1039/C70B02059G
- w Azusa Kondoh, Kazumi Koda, Yuji Kamata, Masahiro Terada, Synthesis of Indolizine Derivatives Utilizing [1,2]-Phospha-Brook Rearrangement/Cycloisomerization Sequence, *Chemistry Letters*, 2017, 1w , 46 s , 2017, 1020-1023.
DOI: 10.1246/cl.170377
- x Azusa Kondoh, Yuji Kamata, Masahiro Terada, Synthesis of Enantioenriched α -Amino- β -unsaturated Esters Utilizing Palladium-Catalyzed Rearrangement of Allylic Carbamates for Direct Application to Formal [3 + 2] Cycloaddition, *Organic Letters*, 1w , 19 s , 2017, 1682-1685.
DOI: 10.1021/acs.orglett.7b00471
- y Azusa Kondoh, Takuma Aoki, Masahiro Terada, Generation and Application of Homoenate Equivalents Utilizing [1,2]-Phospha-Brook Rearrangement under Brønsted Base Catalysis, *Chemistry - A European Journal*, 1w , 23 s , 2017, 2769-2773.
DOI: 10.1002/chem.201605673
- z Azusa Kondoh, Sho Ishikawa, Takuma Aoki, Masahiro Terada, Synthesis of 2,3-allylamides utilizing [1,2]-phospha-Brook rearrangement and their application to gold-catalyzed cycloisomerization providing 2-aminofuran derivatives, *Chemical Communications*, 1w , 52 s , 2016, 12513-12516.
DOI: 10.1039/C6CC06591K
- { Azusa Kondoh, Masahiro Terada, ~~Yuki Kamata~~ -Catalyzed Three-Component Coupling of α -Ketoesters, Imines, and Diethyl Phosphite Utilizing [1,2]-Phospha-Brook Rearrangement, *Organic & Biomolecular Chemistry*, 1w , 2016, 14 s , 4704-4711.
DOI: 10.1039/C70B02059G

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- r Azusa Kondoh, Ring Expansion of Epoxides under Bronsted Base Catalysis: Formal [3+2] Cycloaddition of Epoxides with Imines, *Japanese-Spanish Pre-Symposium in Organic Synthesis in Sendai*, 2018 " 5 v 25 ¥, ~~10~~ dÚ p, • 2F4
- s ~~10~~, 2e)°, ~~10~~, N%, ~~10~~ ~~10~~ [3+2] ~~10~~, 43 GoBb4L ~~10~~, 2017 " 11 v 7 ¥,)R1
- t Azusa Kondoh, Masahiro Terada, Enantioselective Transformation Catalyzed by Chiral Bis(guanidine)iminophosphorane Organosuperbase, *18th Tetrahedron Symposium Asia Edition*, 2017 " 7 v 24 ¥, ~~10~~
- u Azusa Kondoh, Catalytic Generation of Carbanions Utilizing [1,2]-Phospha-Brook Rearrangement and Their Application to C-C Bond Formation, *International Symposium on Pure & Applied Chemistry 2017*, 2017 " 6 v 10 ¥, ~~10~~
- v Azusa Kondoh, Catalytic Generation of Carbanions Utilizing [1,2]-Phospha-Brook Rearrangement and Their Application to C-C Bond Formation, *The 1st International Symposium on Chemical Communication*, 2016 " 10 v 31 ¥, ~~10~~ ~~10~~ Y
- w Azusa Kondoh, Masafumi Oishi, Tadahiro Takeda, Masahiro Terada, Enantioselective C-C Bond Formation Catalyzed by Chiral Bis(guanidine)iminophosphorane Organosuperbase, *11th International Symposium on Carbanion Chemistry*, 2016 " 7 v 20 ¥, ~~10~~

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