アカデミックプログラム［Ｂ講演］｜14. 有機化学—芳香族・複素環・ヘテロ原子化合物：口頭Ｂ講演

2025年3月26日(水) 15:55 ~ 17:15 [F]2304(第4学舎 2号館 [3階] 2304)

[[F]2304-1vn] 14. 有機化学—芳香族・複素環・ヘテロ原子化合物

座長：安井 基博、津留崎 陽大

英語

15:55 ~ 16:15

[[F]2304-1vn-01]

ジアリールクロロニウム塩を用いた第三級アミンの*N*-アリール化による第四級アンモニウム塩の合成

〇大内田 希奈[1]、若藤 空大[1]、山本 英治[1]、吉澤 明菜[1]、徳永 信[1] (1. 九州大学)

英語

16:15 ~ 16:35

[[F]2304-1vn-02]

可視光活性な分子内Frustrated Lewis Pairを鍵中間体とする*p*-ボリルチオフェノールの多機能触媒作用

〇木倉 健翔[1,2]、田浦 悠也[1,2]、荒巻 吉孝[1,2]、大井 貴史[1,2] (1. 名大院工、2. 名大ITbM)

英語

16:35 ~ 16:55

[[F]2304-1vn-03]

アンモニアまたは第一級アミンを用いたアミノベンズヨードキソロンの合成とアリールボロン酸の酸化的アミノ化への活用

〇川中 一輝[1]、清川 謙介[1]、南方 聖司[1] (1. 大阪大学)

英語

16:55 ~ 17:15

[[F]2304-1vn-04]

四置換不斉炭素を有するN,S-アセタール型の非天然α-アミノ酸合成研究

〇飯塚 夕夏[1]、小幡 航希[1]、中村 修一[1] (1. 名工大院工)

ジアリールクロロニウム塩を用いた第三級アミンの*N*-アリール化による第四級アンモニウム塩の合成

（九大院理[1]）○大内田 希奈[1]・若藤 空大[1]・山本 英治[1]・吉澤 明菜[1]・徳永 信[1]

Synthesis of Quaternary Ammonium Salts by *N*-Arylation of Tertiary Amines Using Diarylchloronium Salts

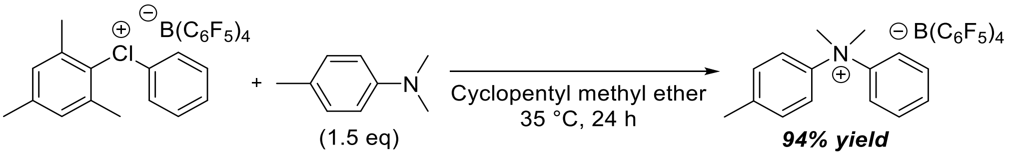
([1]*Graduate School of Science, Kyushu University*) ○Kina Ouchida,[1] Kodai Wakafuji,[1] Eiji Yamamoto,[1] Akina Yoshizawa,[1] Makoto Tokunaga[1]

Quaternary ammonium salts are important compounds that are widely used as antistatic agents and antibacterial agents. Most of them are synthesized by nucleophilic substitution reactions between tertiary amines and alkyl halides, but compounds with low nucleophilicity like anilines are unsuitable for this reaction. *N*-arylation of tertiary amines has been investigated as a method to obtain arylammonium salts, and synthsis methods using benzyne intermediates and diaryliodonium salts have been reported. However, several problems remain related to by-products and the scope of tertiary amines. We present here *N*-arylation of tertiary amines using diarylchloronium salts. This reaction can provide single arylammonium salt products under mild conditions. For example, a reaction of *N,N*-dimethyl-*p*-toluidine employing mesitylphenylchloronium salt as arylating agent in cyclopentyl methyl ether at 35 ℃ afforded the corresponding arylammonium salt in 94% yield.

Keywords : Hypervalent Chlorine Reagent; Quaternization; N-Arylation; Tertiary Amines; Quaternary Ammonium Salts

第四級アンモニウム塩は帯電防止剤や抗菌剤、相間移動触媒など広く用いられている重要な化合物である。その多くは第三級アミンとアルキルハライドの求核置換反応（Menschutkin 反応）で合成されているが、その反応性は第三級アミンの求核性に大きく左右される。求核性の低い芳香族アミンは Menschutkin 反応に不向きであり、アリールアンモニウム塩の合成に関して、第三級アミンの *N*-アリール化による方法が研究されている。これまで、ベンザイン中間体を用いた例1)やジアリールヨードニウム塩を用いた例2), 3)などが報告されているが、溶媒由来の副生成物の存在や生成物の選択性、第三級アミンの適用範囲に課題が残る。本研究では、高い反応性を有するジアリールクロロニウム塩をアリール化剤として用いることで、穏和な条件下で様々な第三級アミンに対し、*N*-アリール化が効率的に進行することを見出した。

実際に、メシチルフェニルクロロニウム塩4)による *N,N*-ジメチル-*p*-トルイジンの *N*-アリール化を、シクロペンチルメチルエーテル中、窒素雰囲気下、35 ℃で行った場合、目的のアリールアンモニウム塩が 94%収率で得られた。



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2) Purkait, N.; Kervefors, G.; Linde, E.; Olofsson, B. *Angew. Chem. Int. Ed*. **2018**, *57*. 11427‑11431.
3) Bugaenko, I. D.; Yurovskaya, A. M.; Karchava, V. A. *Org. Lett.* **2018**, *20*, 6389‑6393.
4) Nakajima, M.; Miyamoto, K.; Hirono, K.; Uchiyama, M. *J. Am. Chem. Soc.* **2019**, *141*, 6499‑6503.

p-Borylthiophenols as Multifunctional Catalysts via Photoactive Intramolecular Frustrated Lewis Pairs

([1]*Graduate School of Engineering, Nagoya University*, [2]*ITbM, Nagoya University*)
○Takeru Kikura[1,2], Yuya Taura[1,2], Yoshitaka Aramaki[1,2], Takashi Ooi[1,2]

Keywords: Photocatalyst, Hydrogen atom transfer, Brønsted acid, Intramolecular charge transfer, Single-electron reduction

Single-electron transfer (SET) within a frustrated Lewis pair (FLP) has been applied to organic synthesis, but most of the reactions require a stoichiometric amount of FLP[1] and catalytic systems remain scarce.[2] Furthermore, even in the few known catalytic reactions, either the Lewis acid or Lewis base functions as a catalyst and there has been no example of utilizing both Lewis acid and base components as catalysts for promoting the target transformation.

In this context, we developed *p*-borylthiophenol as a multifunctional catalyst that operates via an intramolecular FLP (Figure A).[3] Upon acting as a Brønsted acid, it affords an intramolecular FLP capable of absorbing visible light to generate a radical pair of thiyl radical and boron radical anion through photoinduced intramolecular SET. Subsequently, the boron radical anion functions as a single-electron reductant, while thiyl radical facilitates hydrogen atom transfer (HAT) to regenerate *p*-borylthiophenol.

The synthetic utility of *p*-borylthiophenol as a multifunctional catalyst was demonstrated by the application to the synthesis of 1,2-diols and 1,2-aminoalcohols from ketones and benzylic alcohol or amine derivatives (Figure B). In this process, ketones undergo reduction followed by protonation to generate α-hydroxy radicals, whereas benzylic alcohols or amines undergo HAT to form benzylic radicals. The subsequent cross-coupling of these radicals furnishes the target product.

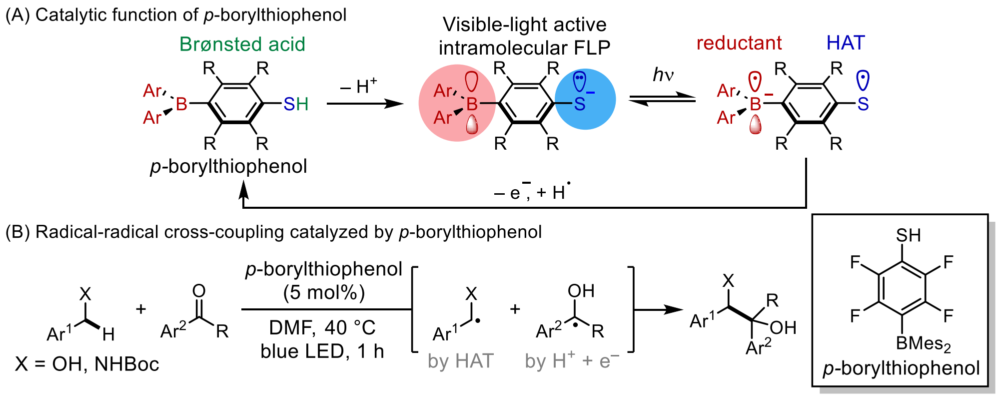


Figure. Development of *p*-borylthiophenol and its application as a multifunctional catalyst.

1) M. Ju, Z. Lu, L. F. T. Novaes, J. I. Martinez Alvarado, S. Lin, *J. Am. Chem. Soc.* **2023**, *145*, 19478. 2) a) Y. Aramaki, N. Imaizumi, M. Hotta, J. Kumagai, T. Ooi, *Chem. Sci.* **2020**, *11*, 4305. b) Yuan, W. Huang, J. Xu, X. Wang, L. Tang, X.-Y. *Org. Lett.* **2021**, *23,* 7139. 3) T. Kikura, Y. Taura, Y. Aramaki, T. Ooi, *J. Am. Chem. Soc.* **2024**, *146*, 20425.

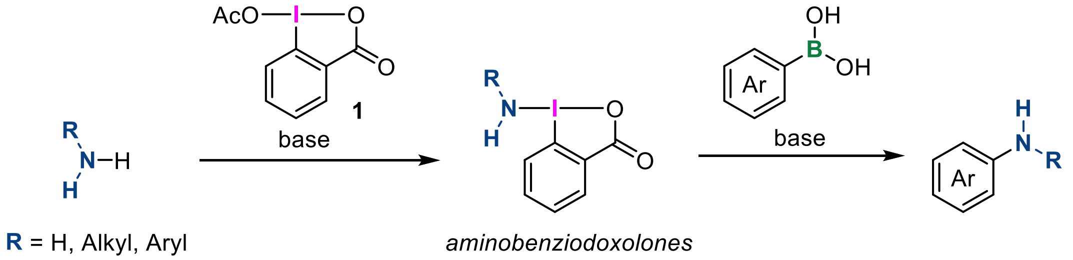
Synthesis of Aminobenziodoxolones Using Ammonia or Primary Amines and Their Application to Oxidative Amination of Arylboronic Acids

(*Graduate School of Engineering, Osaka University*) ○Kazuki Kawanaka, Kensuke Kiyokawa, Satoshi Minakata

Keywords: Amination; Boronic Acids; Hypervalent Iodine; Arylamines; Ammonia

Hypervalent iodine(III) compounds containing transferable nitrogen functional groups are useful reagents for oxidative amination reactions.1) However, most existing reagents contain protected nitrogen functional groups, requiring laborious deprotection steps of the amino functionality installed to access the target amines. To address this challenge, the development of iodine(III) reagents that allow the direct installation of pristine amino groups (amino-λ^3-iodanes) is significant for practical amine synthesis. Recently, iodoxolone-based reagents derived from secondary and benzylic primary amines have been synthesized.1) We have also developed iodine(III) reagents containing amino groups ($-NH_2$, $-NHR$).2) To date, most nitrogen sources for the synthesis of amino-λ^3-iodanes were limited to the use of *N*-silyl amines.1,2) Although the synthesis of aminobenziodoxoles using simple amines has been reported, this method still requires an excess amount of amines, limiting its broader application.3) Therefore, a practical method is desirable that uses a stoichiometric amount of amines to enable the synthesis of diverse amino-λ^3-iodanes.

Herein, we report an efficient method for the synthesis of aminobenziodoxolones using amines. An NH_2-substituted benziodoxolone was synthesized by the reaction of **1** with ammonia. Additionally, the use of a stoichiometric amount of primary amine with a base enabled the preparation of various aminobenziodoxolones. Employing these iodine reagents, the transition-metal-free oxidative amination of arylboronic acids was demonstrated. Furthermore, a simple one-pot procedure for the coupling of amines with boronic acids was achieved through the *in situ* preparation of aminobenziodoxolones. We successfully accomplished the facile synthesis of ^{15}N-labelled arylamines, based on the practical method.



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Asymmetric synthesis of an α-thio-substituted α-amino acid derivatives with quaternary chiral carbon centers

([1]*Nagoya Institute of Technology*)
○Yuka Iizuka,[1] Koki Obata,[1] Shuichi Nakamura[1]

Keywords: *Heteroarene amide group*; *N,S*-acetal; Unnatural α-amino acid

Chiral *N,S*-acetal skeletons are important due to their frequent occurrence in the structure of natural products and pharmaceuticals. One efficient methods for the generation of chiral *N,S*-acetals is the reaction of thiols with imines. The addition reaction using ketiminoesters is particularly important. This method is recognized as a straightforward approach to the synthesis of unnatural α-amino acids with tetrasubstituted stereogenic carbon centres (ATAAs).1) Although many syntheses of ATAAs have been reported in decades due to their significant advantages, there are no reports on the synthesis of sulfur-containing ATAAs using acyclic ketiminoesters due to the difficulty in controlling the enantioselectivity. Recently, we reported the highly enantioselective addition of thiols to ketimines derived from isatins and azirines using cinchona alkaloid sulfonamide catalysts developed by our group. 2) Based on our previous work, we performed the first asymmetric addition of thiols to acyclic ketiminoesters to construct α-thio-substituted α-amino acid derivatives with tetrasubstituted stereogenic carbon centers.

At the beginning of this study, ketiminoester **1a** and benzyl mercaptan **2a** were chosen as model substrates. As a result of various optimizations, good yields and enantioselectivities were obtained using our original cinchona alkaloid amide/zinc (II) catalysts (Figure 1). Furthermore, the obtained products were converted into useful chiral thiazolidines. Based on experimental results and DFT calculations, the proposed transition states provided a plausible explanation for the stereoselectivity of the reaction.3)

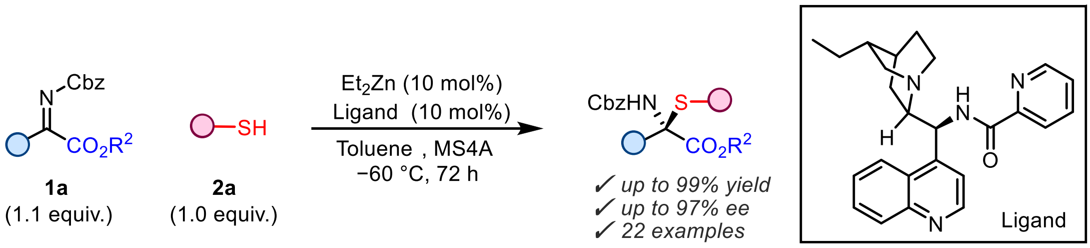

Figure 1

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