Literature Report IX

Synthesis of β-Aminoboronates by Copper(I)-Catalyzed Addition of Diborylalkanes to Imines

Reporter : Shubo Hu

Checker : Xiaoyong Zhai

Date : 2017-9-18

Cho, S. H. *et al. Org. Lett.* **2016**, *18*, 1210.
Cho, S. H. *et al. Angew. Chem. Int. Ed.* **2017**, *56*, 11584.

Contents

CV of Seung Hwan Cho

Seung Hwan Cho

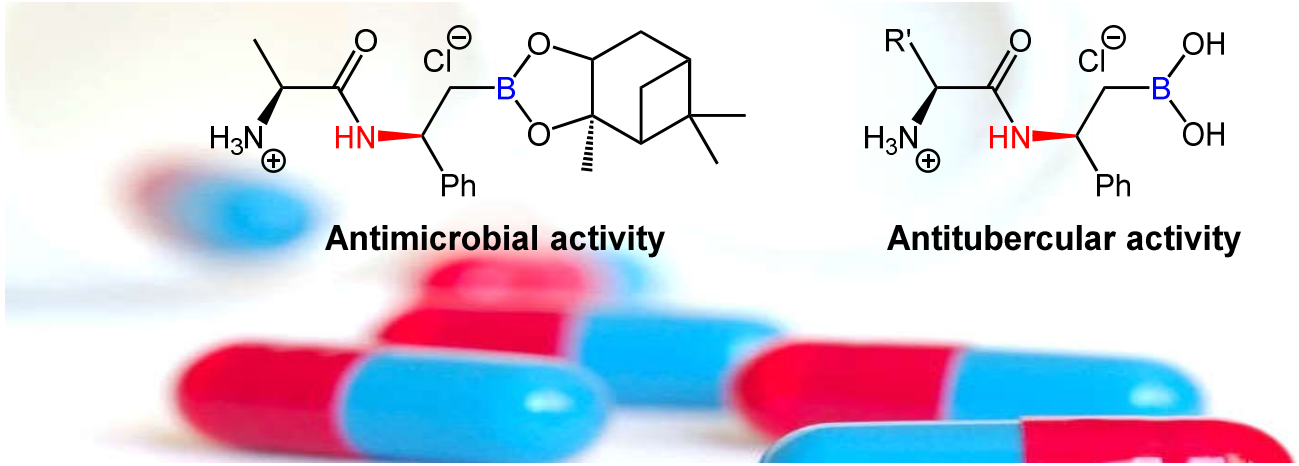
Education:

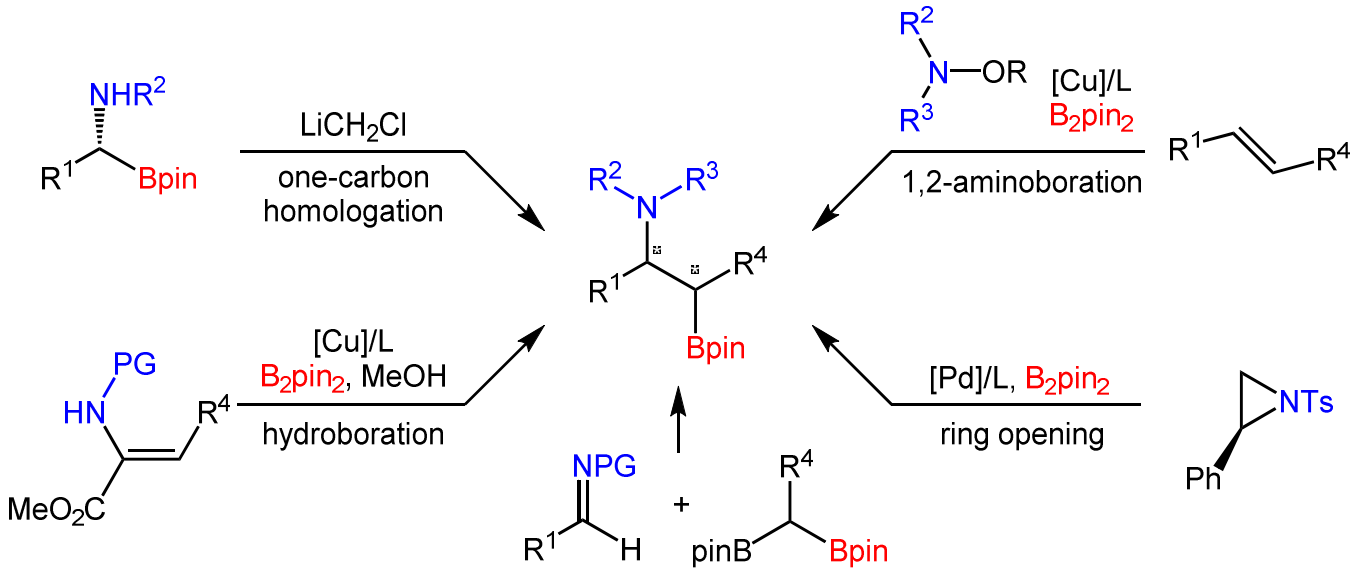
- **2001–2005** B.S. in Chemistry KAIST
- **2005–2006** Researcher at KAIST
- **2006–2011** Ph.D. in Chemistry KAIST (Prof. Sukbok Chang)
- **2011–2012** Postdoc. at KAIST (Prof. Sukbok Chang)
- **2012–2014** Postdoc. at UC Berkeley (Prof. John F. Hartwig)
- **2014–2017** Assistant Professor Dept. of Chemistry, POSTECH

Research:

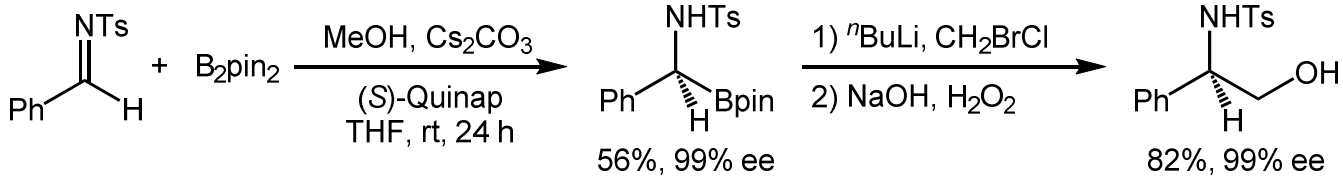
- Transition-metal-free C-C/C-B bond formation reactions;
- Transition-metal-catalyzed chemo-, regio-, and stereoselective C-C bond formation reactions.

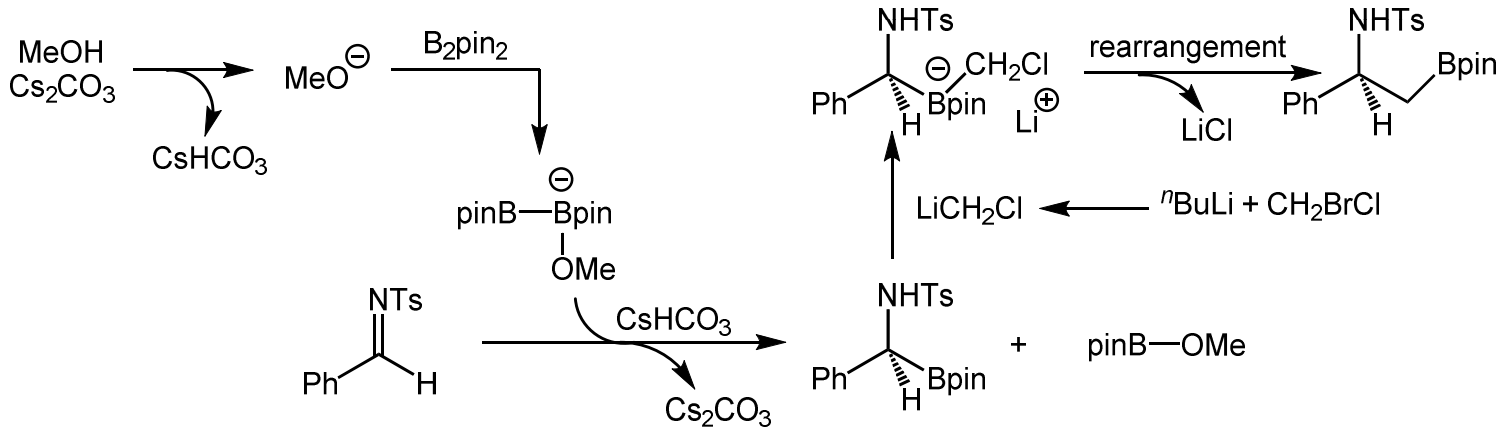
Introduction





Introduction





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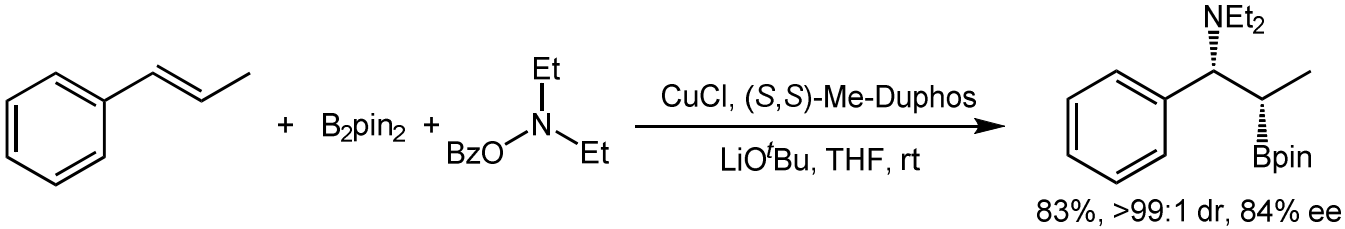
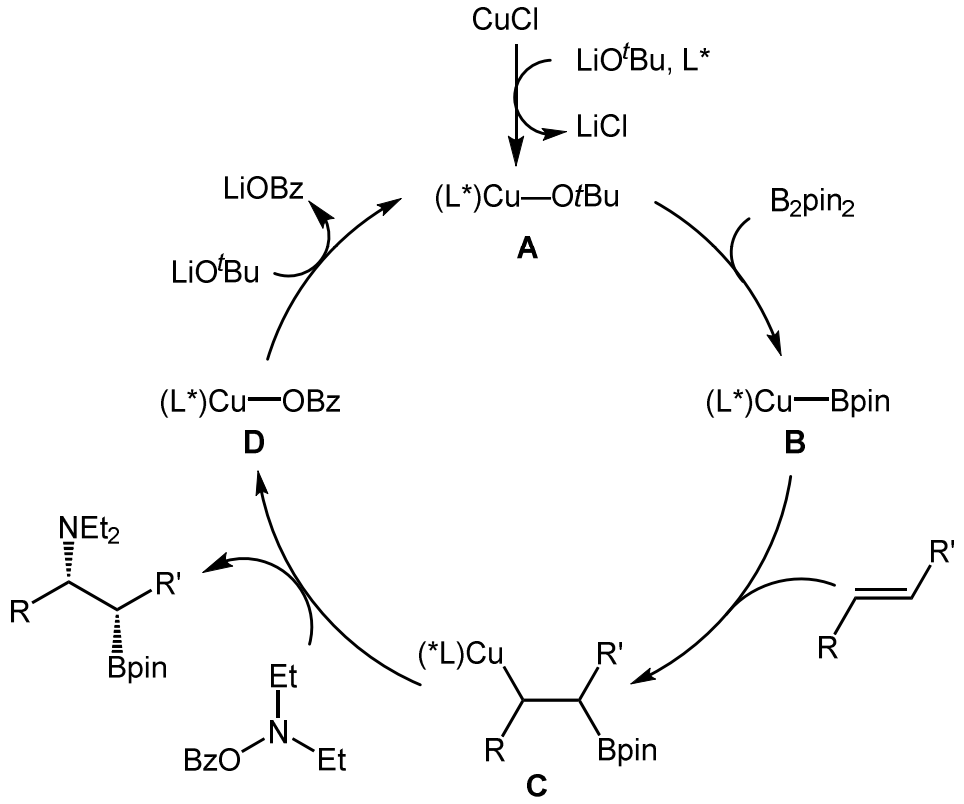
Introduction





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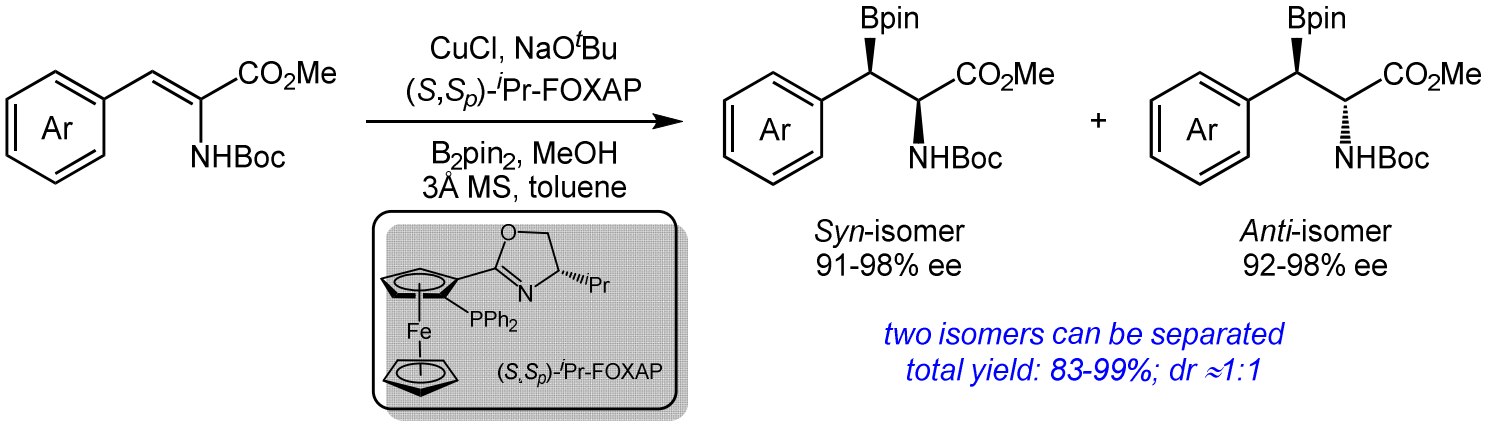
Introduction



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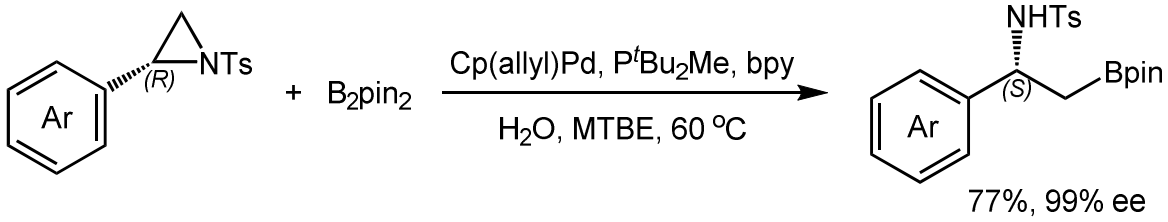

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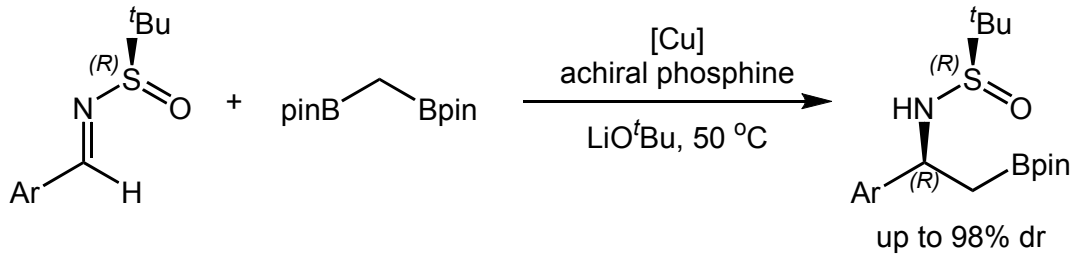
Introduction



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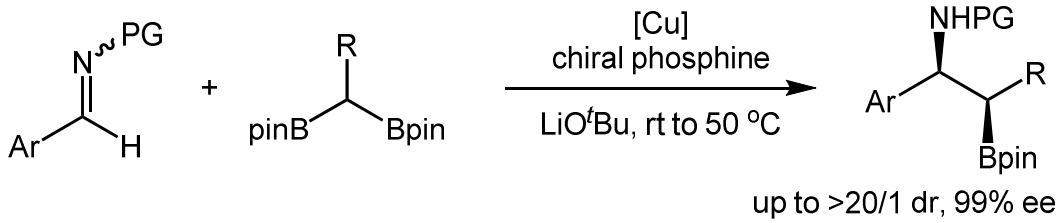

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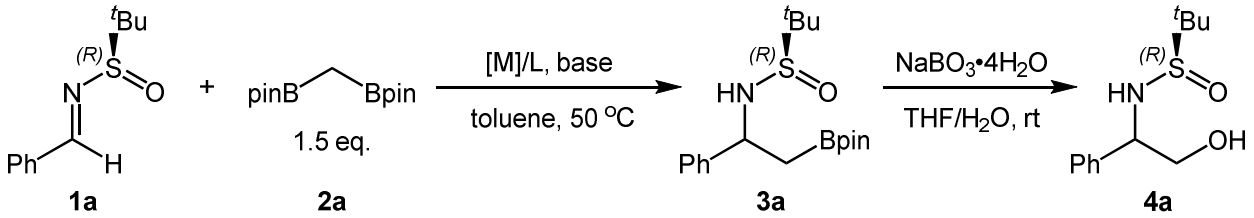
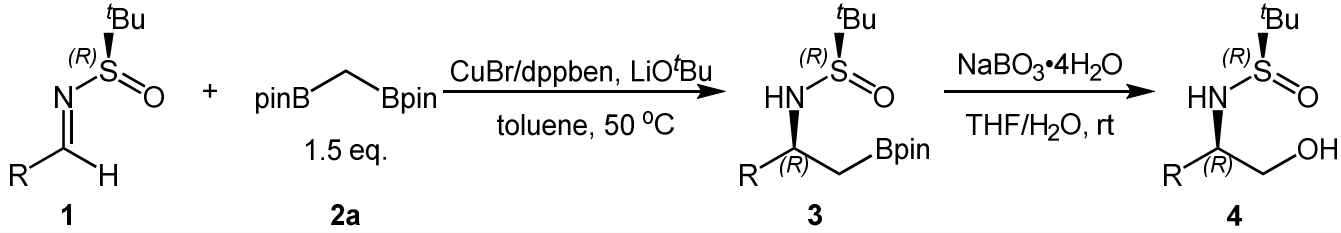
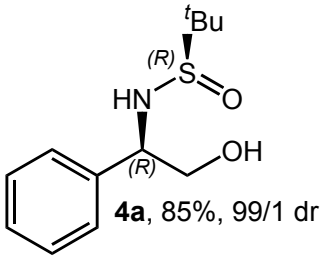
Addition of Diborylmethane to Aldimines

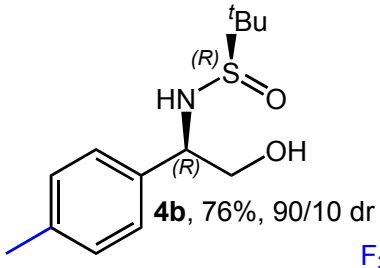


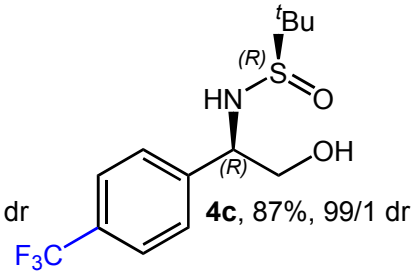
Entry[a]	Base (3 eq.)	[M] (10 mol%)	L (10 mol%)	Conv. (**1a**) (%)	Yield (**4a**) (%)	dr (**4a**)
1	LiO^{t}Bu	--	--	<1	<1	n.d.
2	NaO^{t}Bu	--	--	100	96	77/23
3	KO^{t}Bu	--	--	100	86	54/46
4	LiO^{t}Bu	$[Rh(COD)Cl]_2$	dppben	39	15	83/17
5	LiO^{t}Bu	$Cu(OTf)_2$	dppben	78	66	97/3
6	LiO^{t}Bu	$Cu(OTf)_2$	dppb	56	54	95/5
7	LiO^{t}Bu	$Cu(OTf)_2$	PPh_3	33	15	96/4
8	LiO^{t}Bu	$Cu(OTf)_2$	PCy_3	62	50	95/5
9	LiO^{t}Bu	CuCl	dppben	90	61	98/2
10	LiO^{t}Bu	CuBr	dppben	100	91	99/1
11	--	CuBr	dppben	<1	<1	n.d.
12	LiO^{t}Bu	CuBr	--	50	24	n.d.

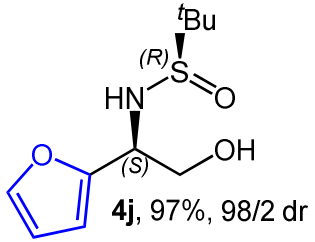
Addition of Diborylmethane to Aldimines

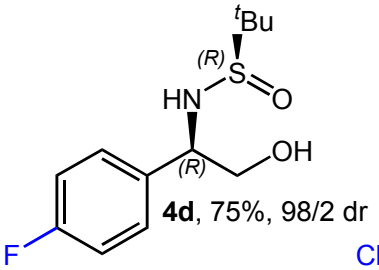


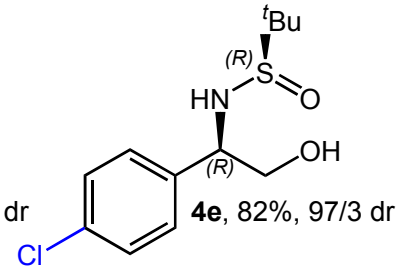


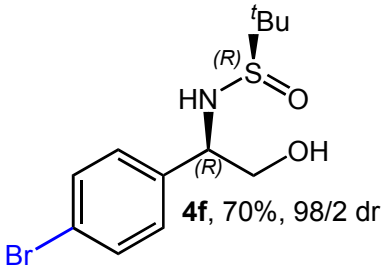


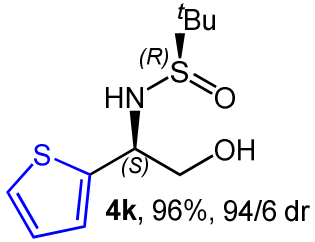


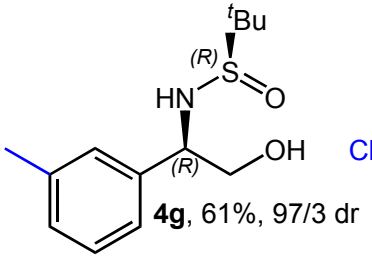


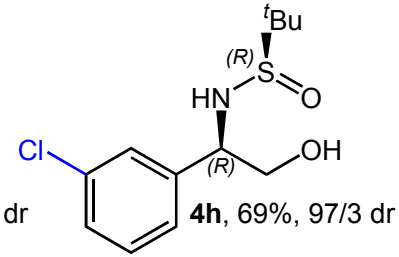


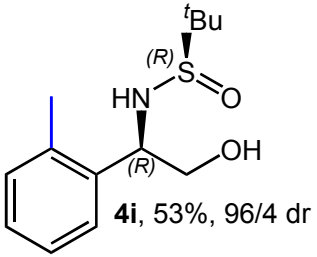


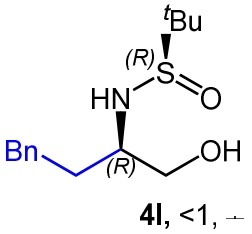




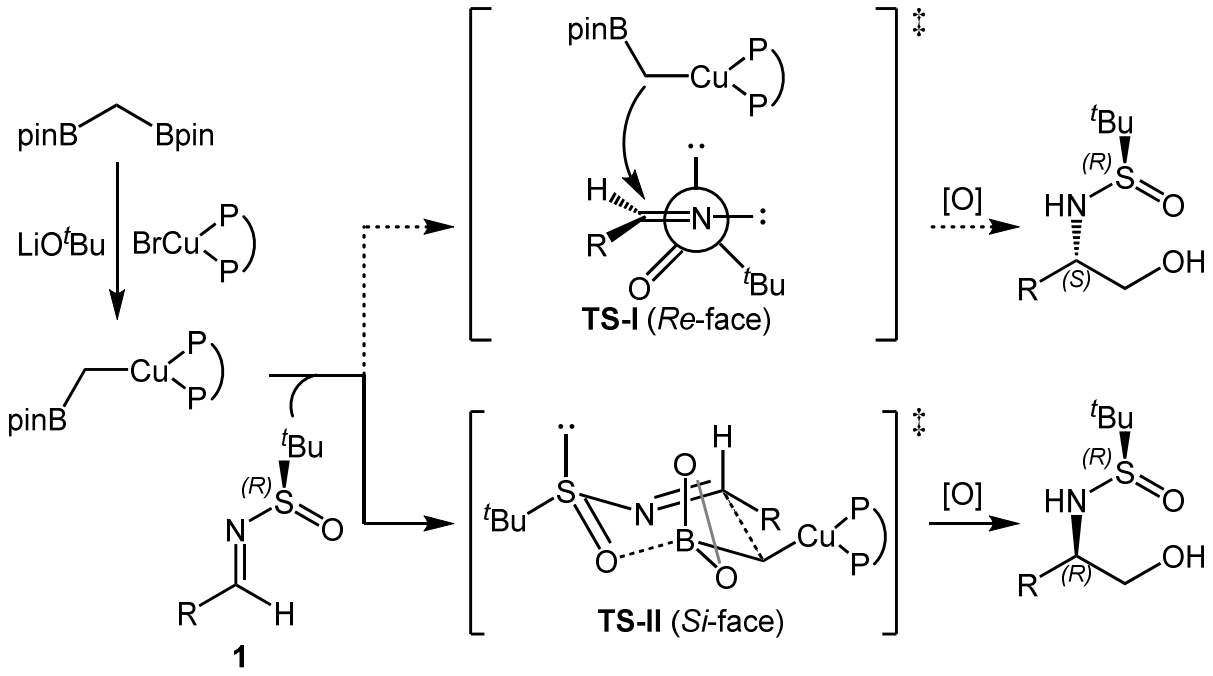




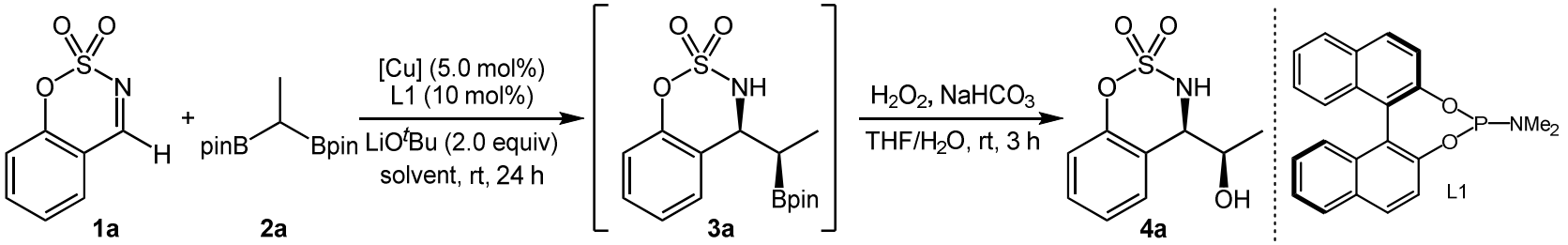




Addition of Diborylmethane to Aldimines



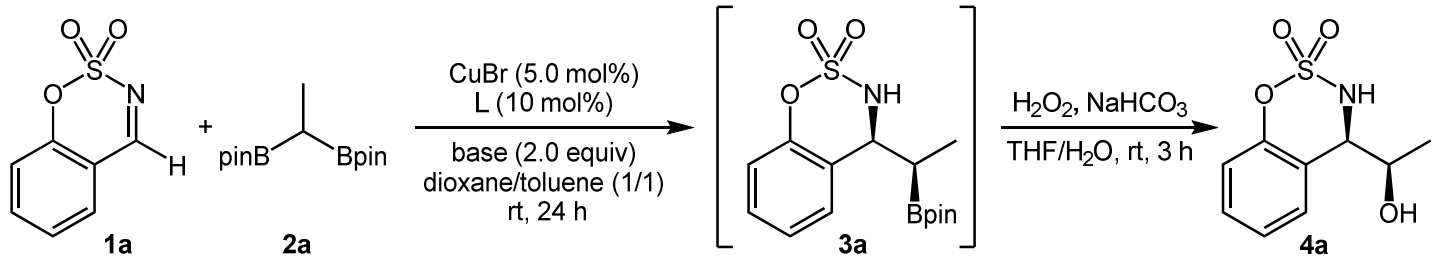
Addition of 1,1-Bis[(pinacolato)boryl]alkanes to Imines



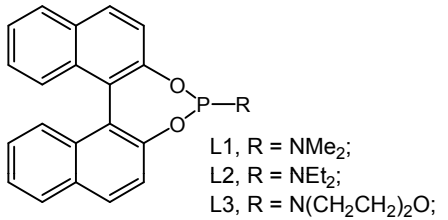
1a **2a** **3a** **4a**

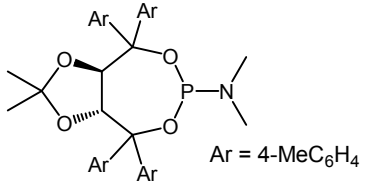
Entry[a]	[Cu]	Solvent	Yield (**4a**) (%)	dr (**4a**)	Ee (%)
1	CuBr	dioxane	94	14/1	98
2	CuBr	THF	93	11/1	99
3	CuBr	Toluene	<1	n.d.	n.d.
4	CuBr	dioxane/toluene (1:1)	98 (98)	>20/1	99
5	CuCl	dioxane/toluene (1:1)	95	>20/1	98
6	CuI	dioxane/toluene (1:1)	71	>20/1	97
7	$Cu(NCMe)_4PF_6$	dioxane/toluene (1:1)	94	>20/1	99
8	$Cu(OAc)_2$	dioxane/toluene (1:1)	94	>20/1	98

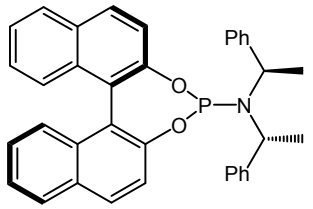
Addition of 1,1-Bis[(pinacolato)boryl]alkanes to Imines



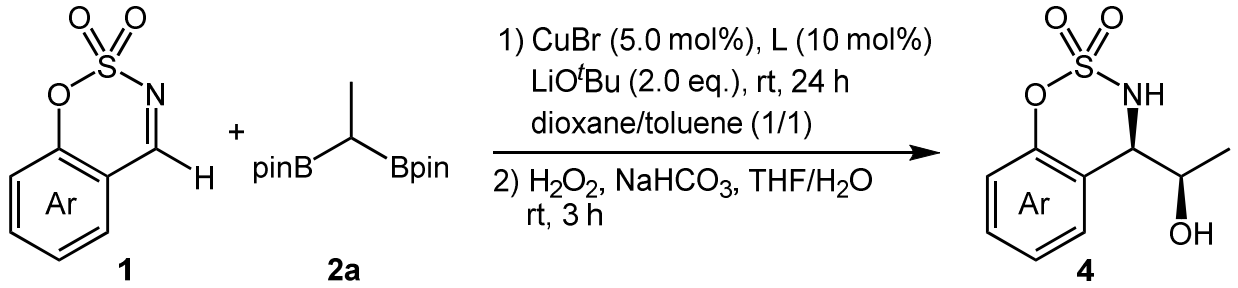
Entry[a]	L	Base	Yield (**4a**) (%)	dr	Ee (%)
1	L1	LiO^{t}Bu	98	>20/1	99
2	L2	LiO^{t}Bu	87	>20/1	98
3	L3	LiO^{t}Bu	95	>20/1	99
4	L4	LiO^{t}Bu	94	>20/1	98
5	L5	LiO^{t}Bu	<1	n.d.	n.d.
6	L6	LiO^{t}Bu	<1	n.d.	n.d.
7	L1	NaO^{t}Bu	13	2/1	n.d.
8	L1	KO^{t}Bu	54	1/1	n.d.
9	L1	LiO^{t}Am	81	19/1	98

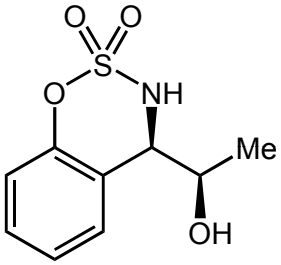




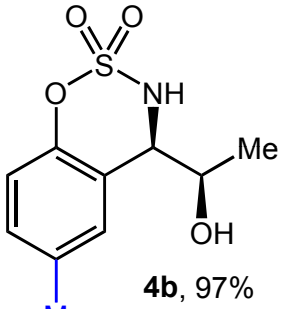


Addition of 1,1-Bis[(pinacolato)boryl]alkanes to Imines

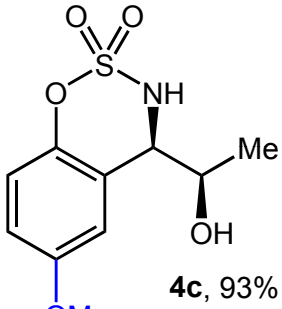




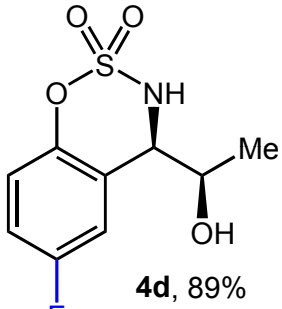
4a, 98%
>20/1 dr, 99% ee



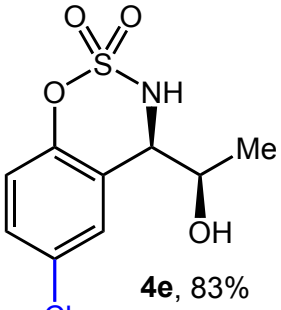
4b, 97%
18/1 dr, 98% ee



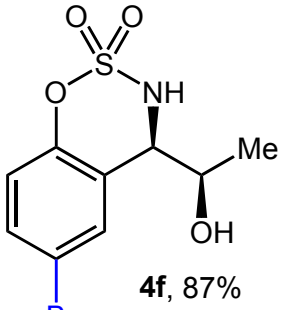
4c, 93%
15/1 dr, 98% ee



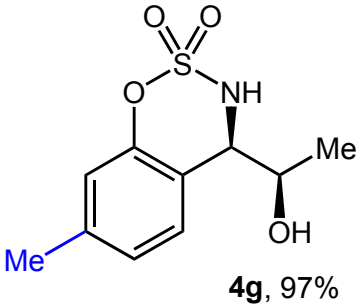
4d, 89%
15/1 dr, 98% ee



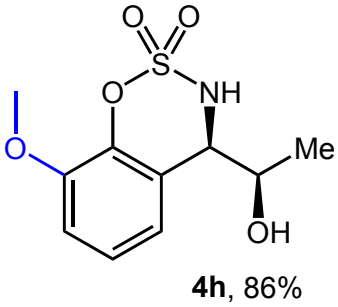
4e, 83%
11/1 dr, 99% ee



4f, 87%
10/1 dr, 97% ee

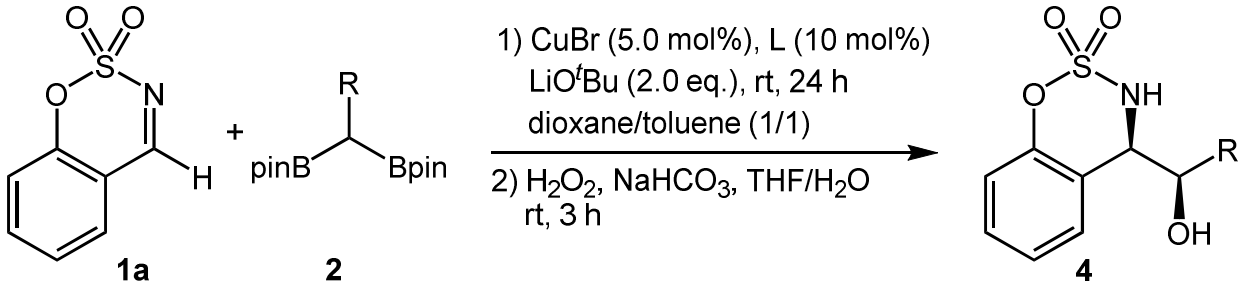


4g, 97%
>20/1 dr, 96% ee

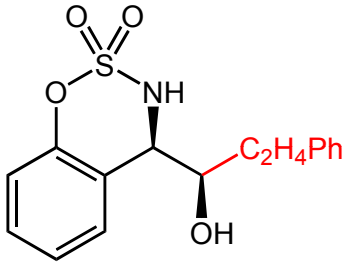


4h, 86%
15/1 dr, 98% ee

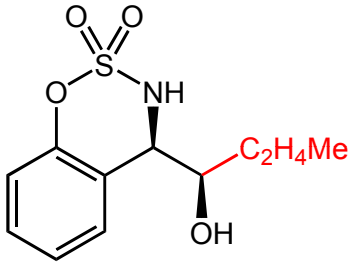
Addition of 1,1-Bis[(pinacolato)boryl]alkanes to Imines



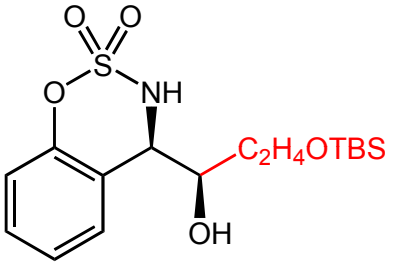
1a **2** **4**



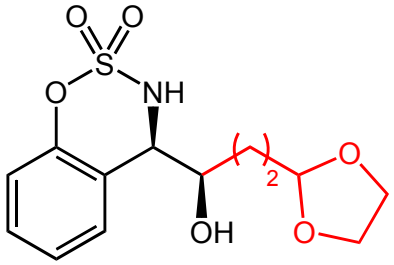
4i, 77%
>20/1 dr, 99% ee



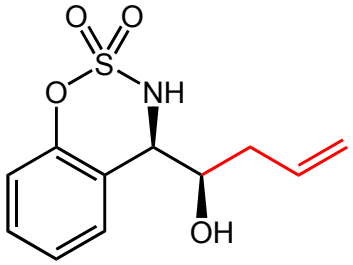
4j, 69%
>20/1 dr, 99% ee



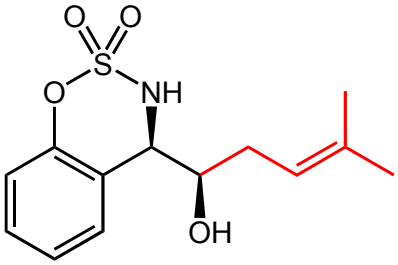
4k, 81%
>20/1 dr, 93% ee



4l, 42%
>20/1 dr, 93% ee

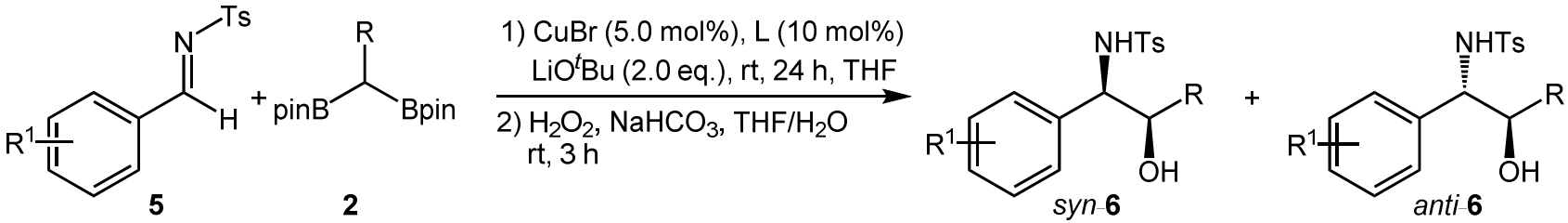


4m, 83%
>20/1 dr, 98% ee



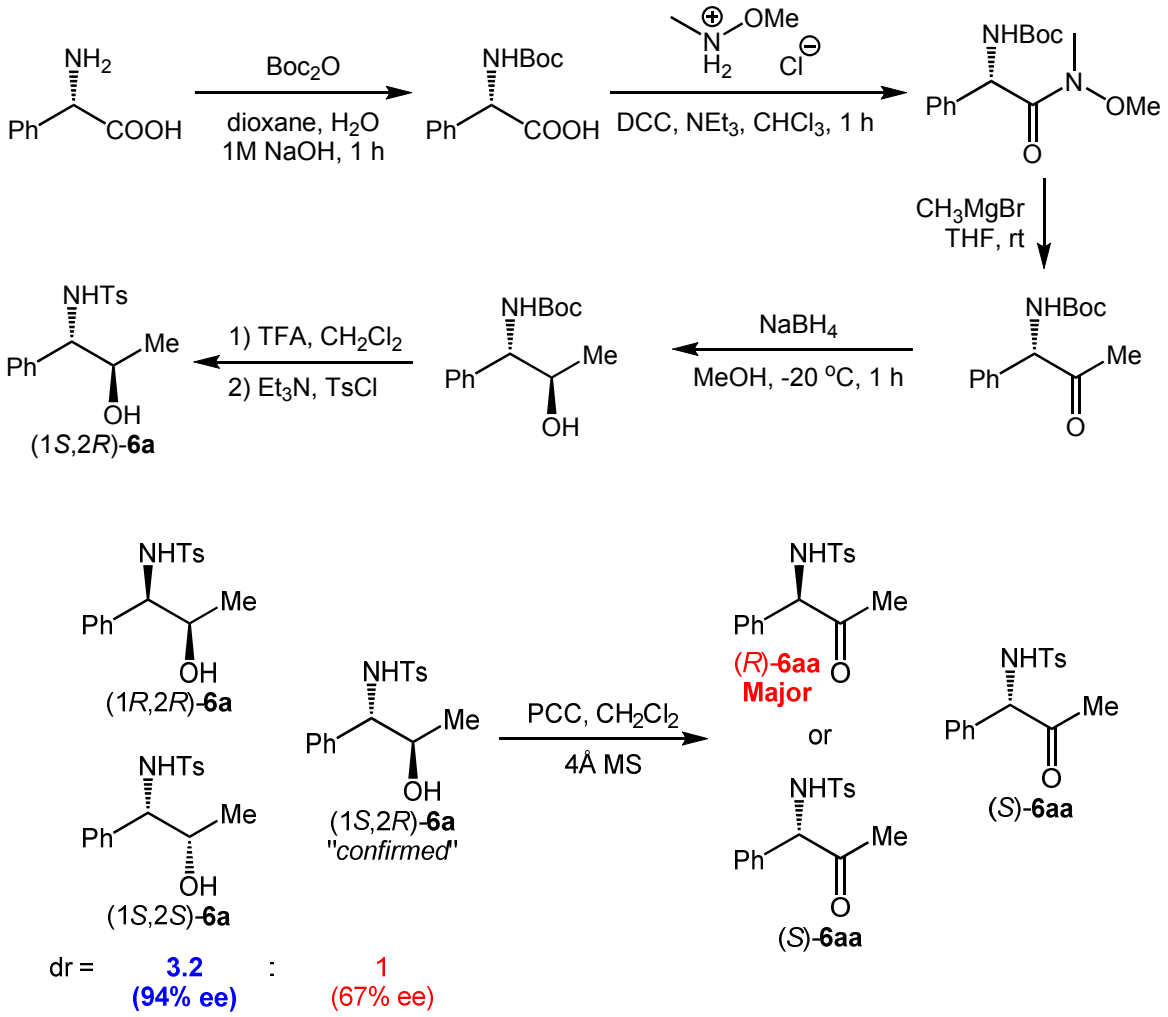
4n, 67%
>20/1 dr, 99% ee

Addition of 1,1-Bis[(pinacolato)boryl]alkanes to Imines

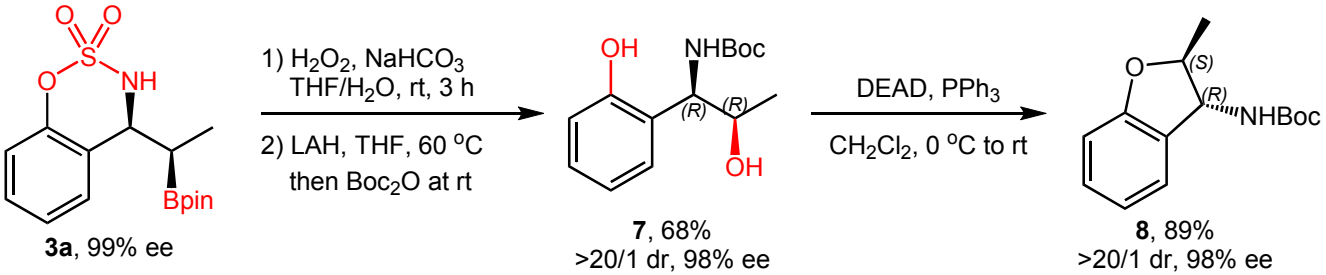


Entry[a]	R^1	R^2	Yield (%)	dr	Ee (%)
1	H	Me	92 (**6a**)	3.2/1	94 (67)
2	H	Pr	67 (**6b**)	3.5/1	98 (91)
3	H	C_2H_4Ph	53 (**6c**)	4.9/1	98 (94)
4	4-Me	Me	72 (**6d**)	3.6/1	96 (76)
5	4-Cl	Me	65 (**6e**)	3.2/1	96 (77)

Addition of 1,1-Bis[(pinacolato)boryl]alkanes to Imines



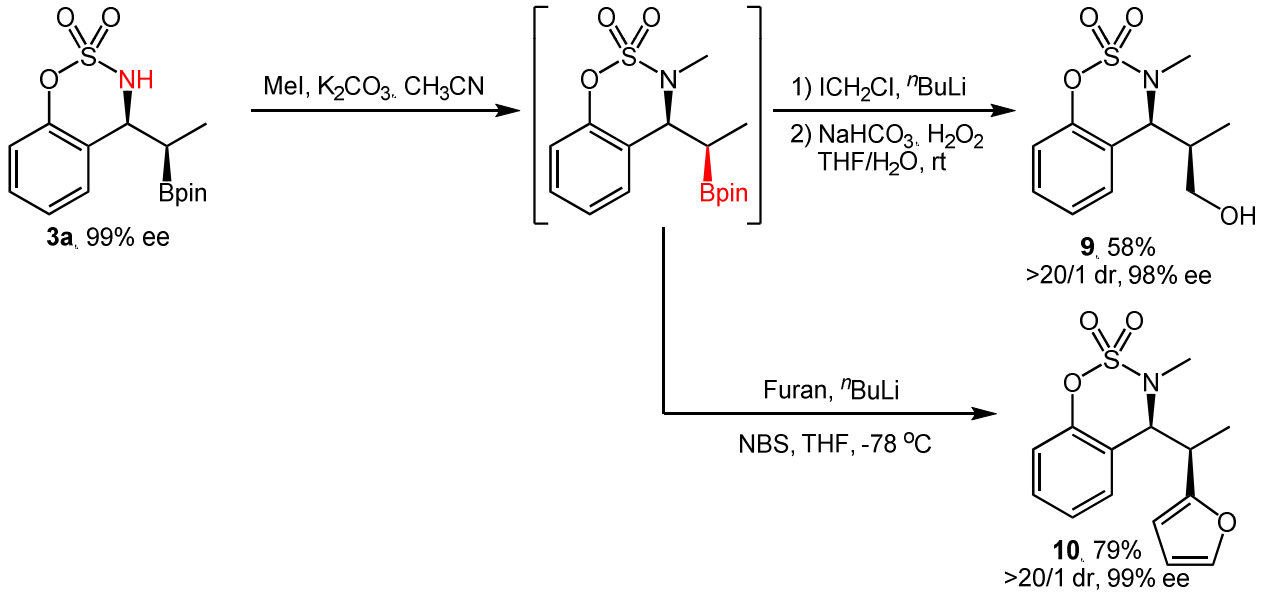
Addition of 1,1-Bis[(pinacolato)boryl]alkanes to Imines



3a, 99% ee

7, 68%
>20/1 dr, 98% ee

8, 89%
>20/1 dr, 98% ee

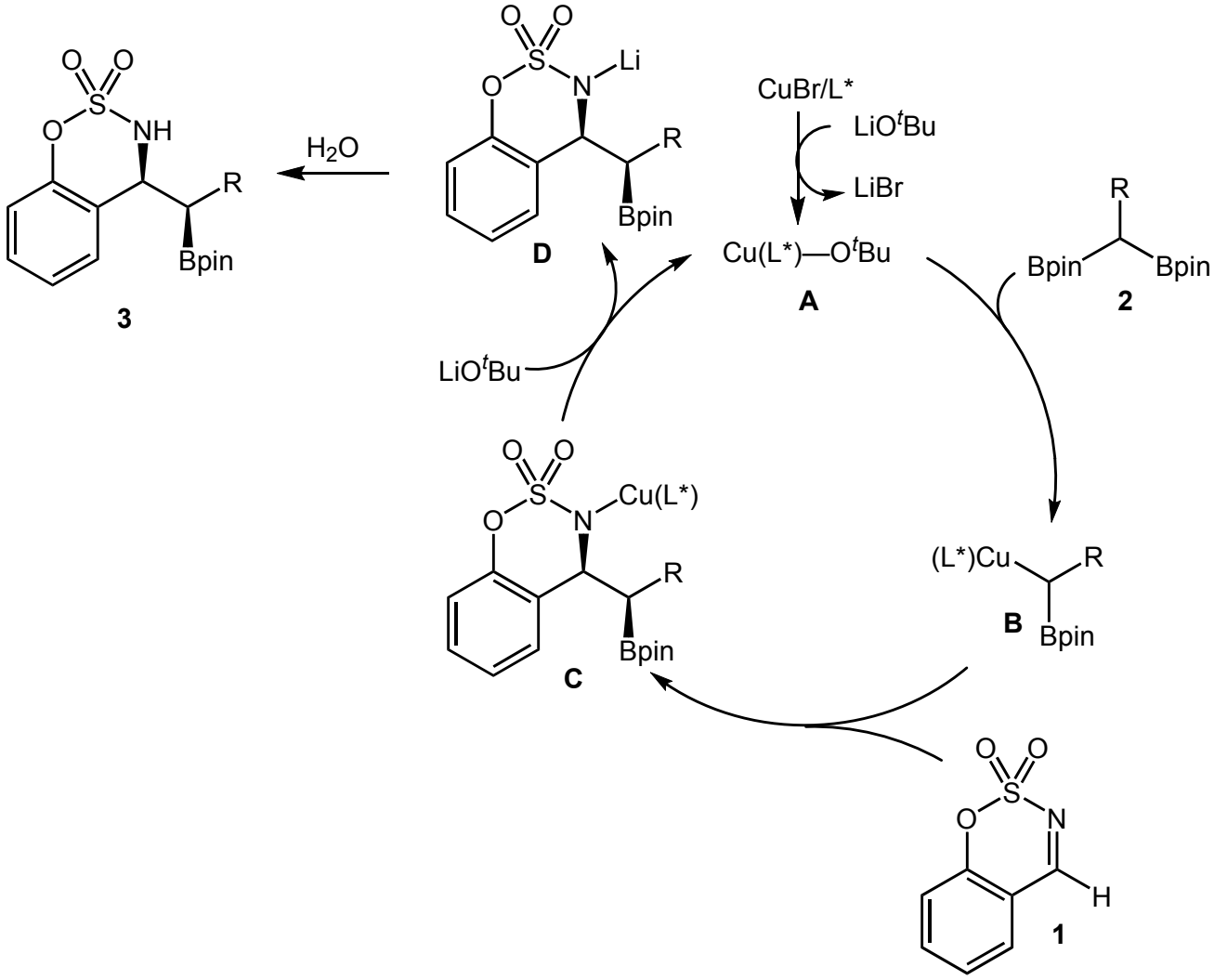


3a, 99% ee

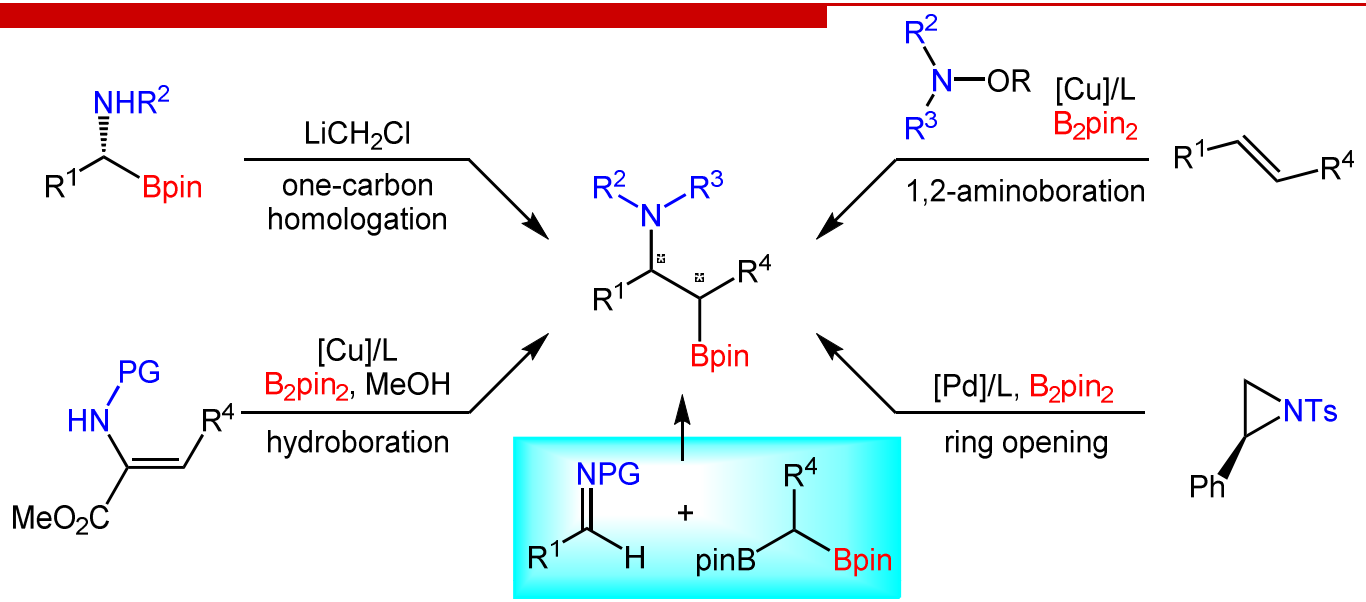
9, 58%
>20/1 dr, 98% ee

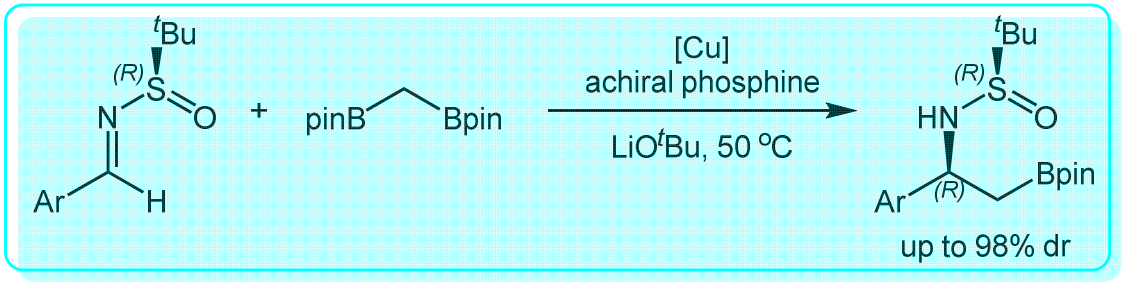
10, 79%
>20/1 dr, 99% ee

Addition of 1,1-Bis[(pinacolato)boryl]alkanes to Imines



Summary





Cho, S. H. *et al*. *Org. Lett*. **2016**, *18*, 1210; *Angew. Chem. Int. Ed.* **2017**, *56*, 11584.

The first paragraph

Chiral organoborons are an important class of synthetic intermediates which can undergo a range of carbon–carbon and carbon–heteroatom bond-forming reactions by stereospecific couplings. The synthesis of such compounds containing a nitrogen functionality at the β-position of the chiral boron unit is of significant importance in synthetic chemistry because they serve as versatile building blocks in many biologically active compounds. Consequently, several synthetic methods have been developed to afford chiral β-aminoborons. In this context, several elegant catalytic enatioselective methods have emerged for the preparation of chiral β-aminoborons under mild reaction conditions. Despite these advances, the development of a new approach from readily accessible imines remains elusive but is highly desirable.

The last paragraph

In summary, we have developed a highly diastereo- and enantioselective, copper-catalyzed 1,2-addition of 1,1-bis[(pinacolato)boryl]alkanes to N-protected imines. With a CuBr/chiral phosphoramidite catalyst and LiO^{t}Bu, the reactions proceed to generate a broad range of b-aminoboronate esters with contiguous stereocenters in high yields. The products are highly synthetically useful, as demonstrated by further functionalizations of the Bpin unit to form new C-O or C-C bonds upon C-B bond cleavage. Efforts to expand the scope of the diastereo- and enantiostereoselective 1,2-addition employing 1,1-bis[(pinacolato)boryl]alkanes are currently underway in our laboratory.