

MIYAURA BORATION

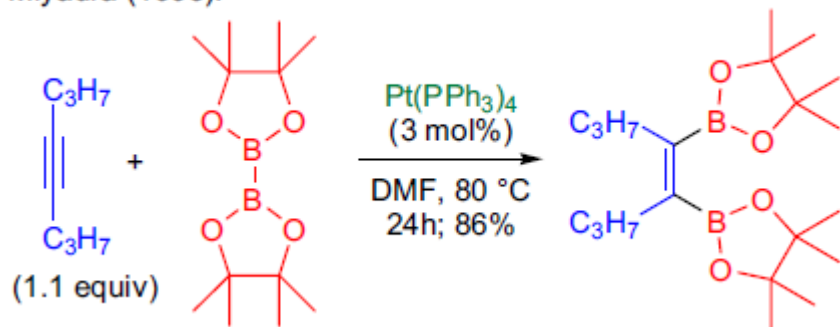
2016.6.28

Guanshen Zhou

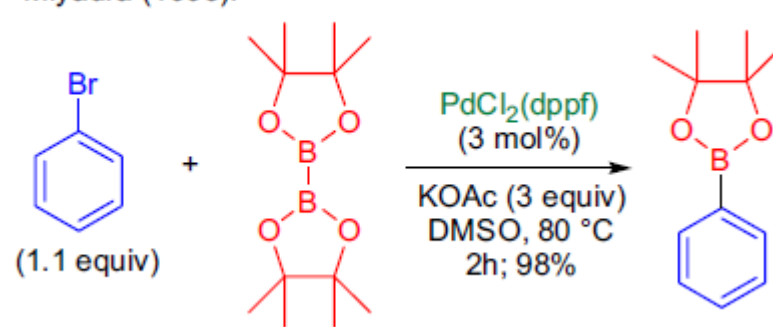
Discovery of Miyaura boration

- In 1993, it was discovered that alkynes could be efficiently cis-diborated with the B_2pin_2 in the presence of catalytic amounts of $Pt(PPh_3)_4$.
- In 1995, the same authors discovered that B_2pin_2 could be coupled with aromatic halides in the presence of catalytic amounts of $PdCl_2(dppf)$ to afford arylboronic esters. Only Pd based catalysts were effective.

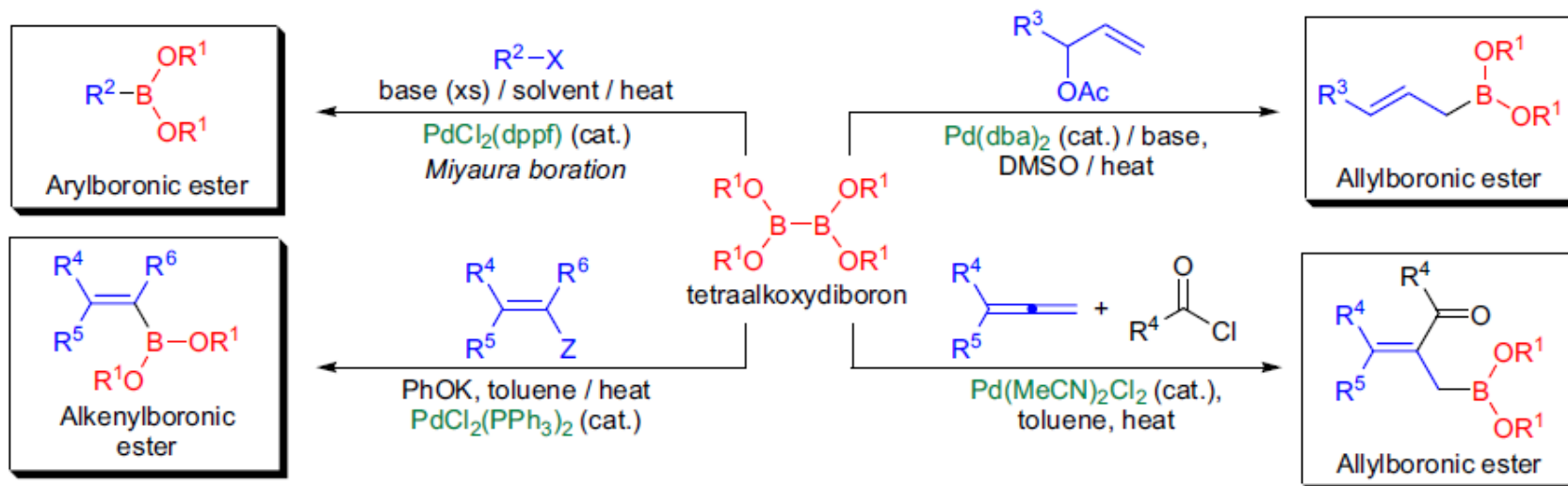
Miyaura (1993):



Miyaura (1995):

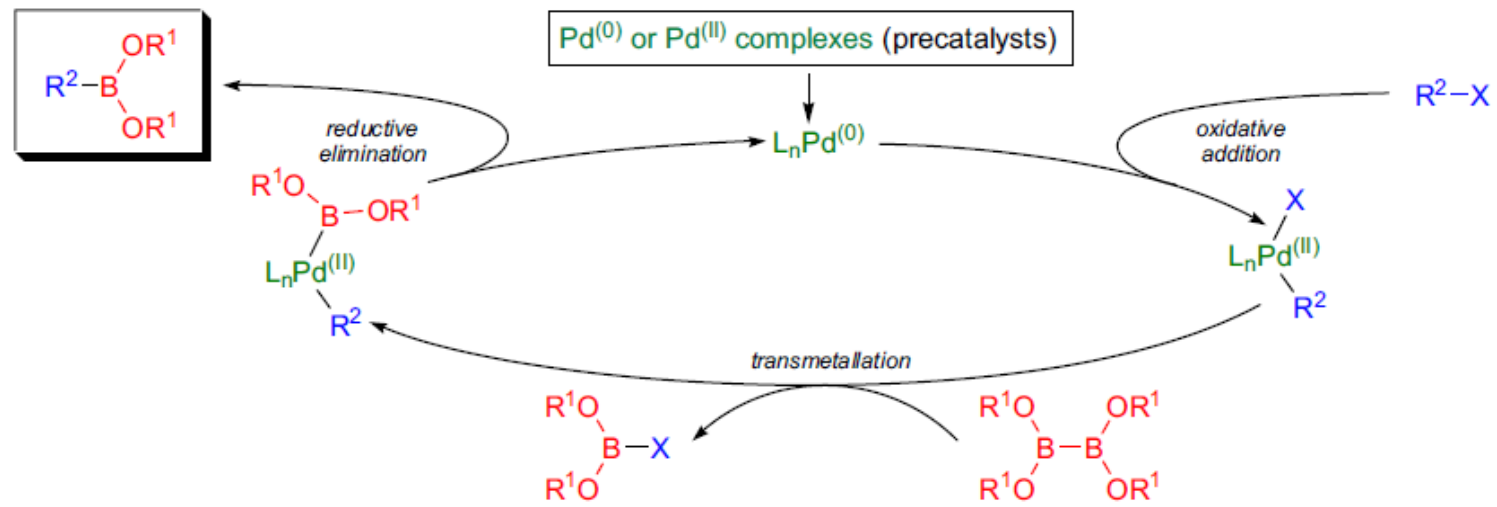


Several Modifications



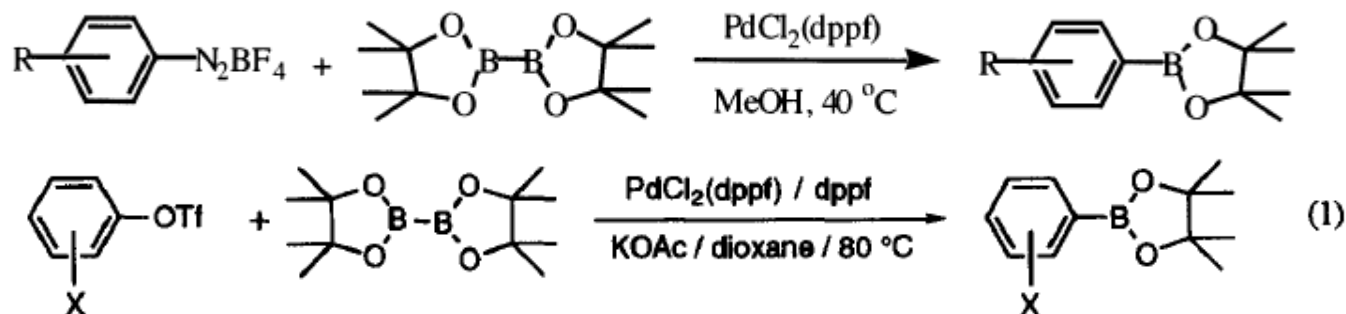
R^1 = alkyl; R^2 = aryl, heteroaryl; R^3 = H, alkyl, aryl; $R^{4,6}$ = alkyl, aryl; X = Br, I, (or Cl) OTf, N_2BF_4 ; Z = I, Br, OTf; base: KOAc; solvent: DMF, DMSO, dioxane, toluene

Mechanism



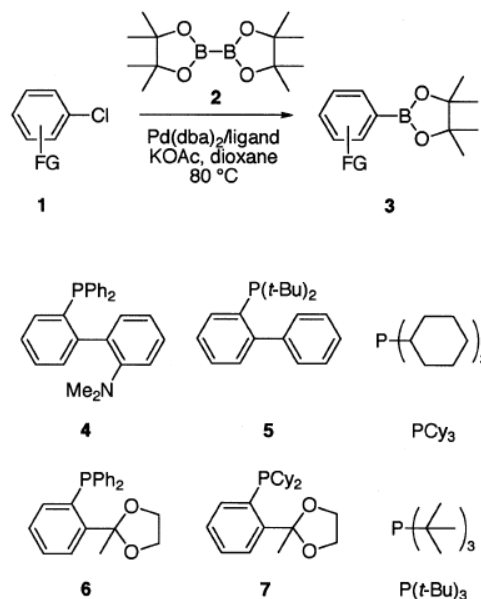
General features

- One-pot coupling proceeds under mild conditions, and most functional groups are tolerated under the mildly basic reaction conditions;
- Best substrates are aryl bromides and iodides, aryl triflates and aryldiazonium tetrafluoroborates have also been used;
- Potassium acetate (KOAc) is critical for the successful coupling of aryl halides, which not only accelerates the reaction but also prevents the formation of biaryl by-products (Suzuki cross-coupling).



General features

- The aryl group may have either electron-donating or electron-withdrawing substituents; and electron-rich aryl bromides tend to react slower than electron-rich aryl iodides;
- The use of palladium(0)-tricyclohexylphosphine as the catalyst allows the coupling of the much less reactive aryl chlorides



Entry	Ligand	Ligand (equiv.) ^a	Yield (%) ^b
1	None		1
2	PPh_3	2.4	19
3	$\text{P}(o\text{-MeC}_6\text{H}_4)_3$	2.4	36
4	$\text{P}(p\text{-MeOC}_6\text{H}_4)_3$	2.4	44
5	dppf ^c	1.1	18
6	4	1.1	78
7	5	2.4	68
8	6	1.1	10
9	7	1.1	71
10	PCy_3	2.4	94
11	$\text{P}(t\text{-Bu})_3$	2.4	58

Synthetic Applications

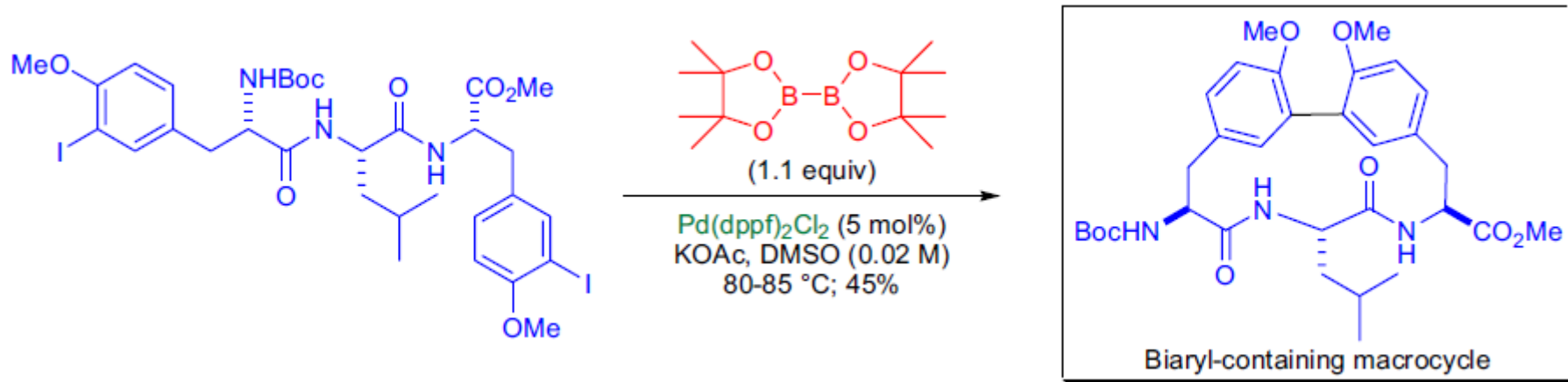


Table 1. Pd(dppf)₂Cl₂ (0.05 equiv) Catalyzed Cyclization of **11** in the Presence of Diboron Ester **13** (1.1 equiv)

entry	base	solvent	concn, M	temp, °C	12 (%) ^a
1	KOAc	DMSO	0.005	40–45	trace ^b
2	KOAc	DMSO	0.02	40–45	trace ^b
3	KOAc	DMSO	0.005	80–85	10% ^c
4	KOAc	DMSO	0.02	80–85	45% ^c
5	KOAc	DME	0.2	80–85	0% ^b
6	KOAc	DME	0.02	80–85	0% ^b
7	Na ₂ CO ₃	DME	0.02	80–85	0% ^b
8	K ₂ CO ₃	DMSO	0.02	80–85	trace ^b
9	KOAc–K ₂ CO ₃	DMSO	0.02	80–85	trace ^b

^a Mono- and bisdeiodination products are the major isolable side products. However, the overall mass balance was generally poor. ^b Detected by MS. ^c Isolated yield.

Synthetic Applications

