

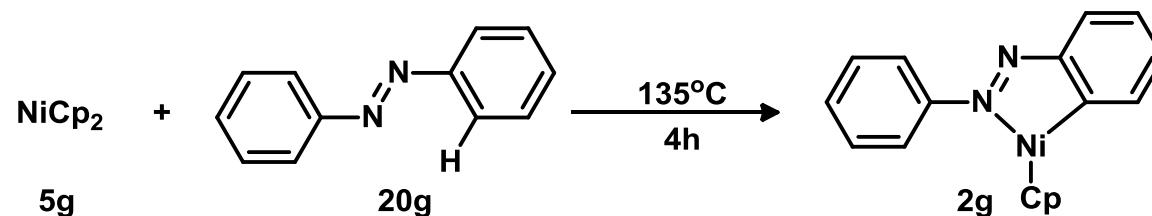
Nickel catalyzed C-H functionalization

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Supervisor: Prof. Yong Huang
2014.05.05

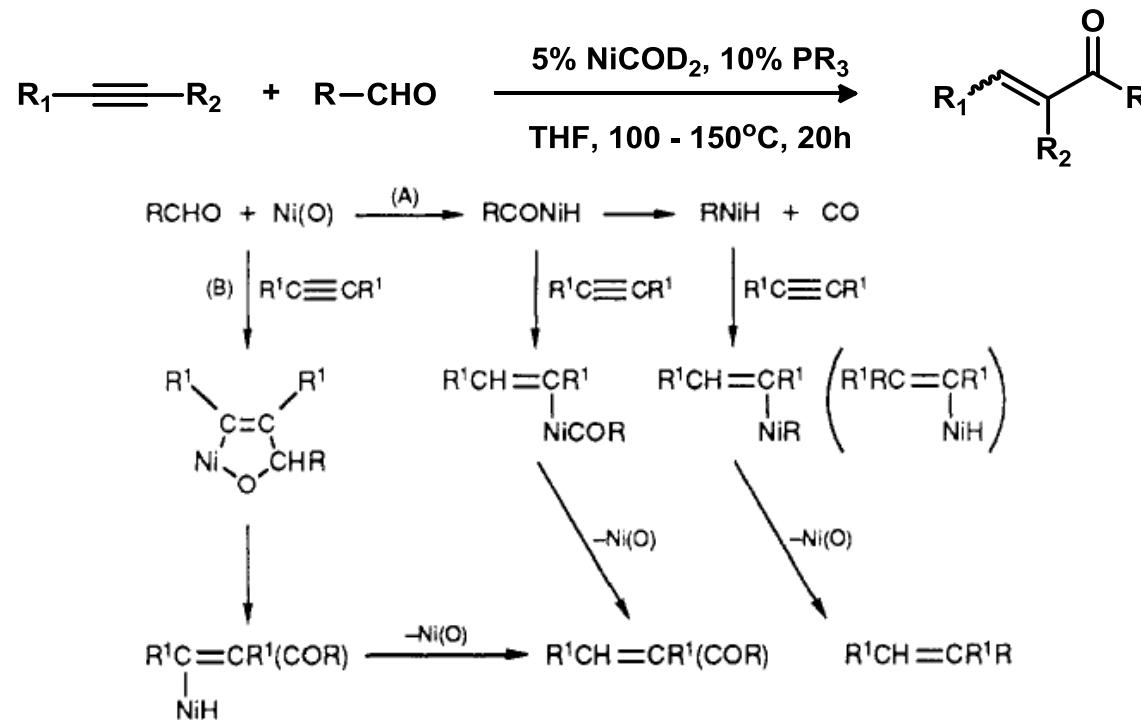
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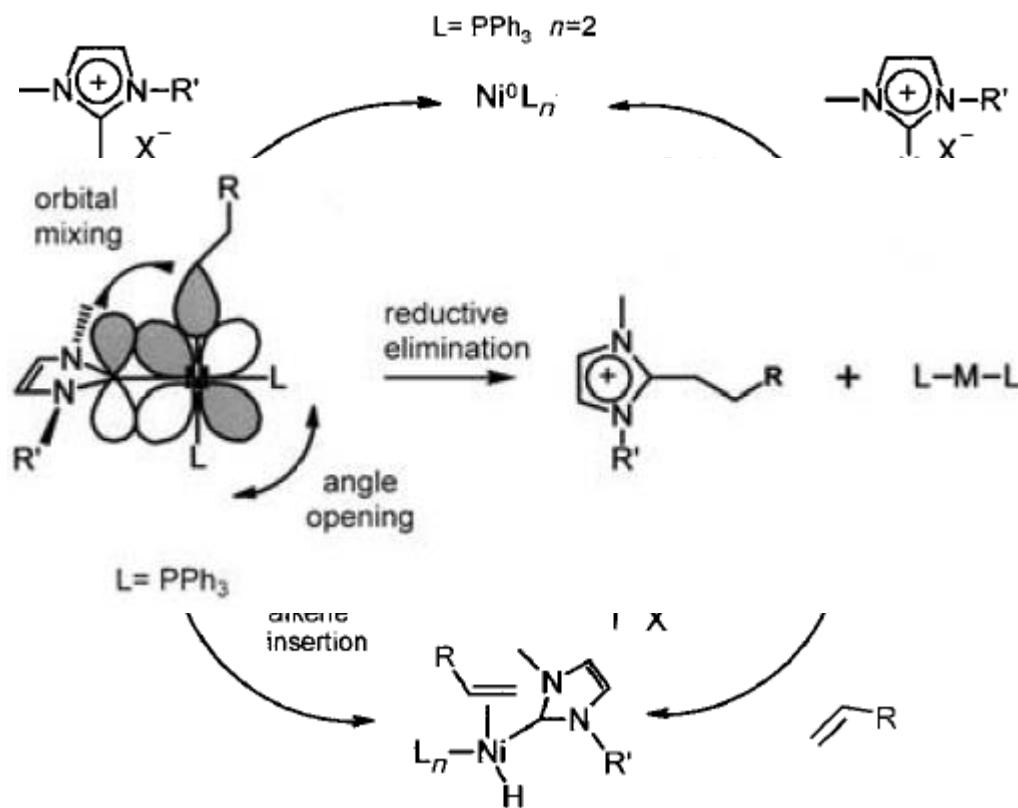
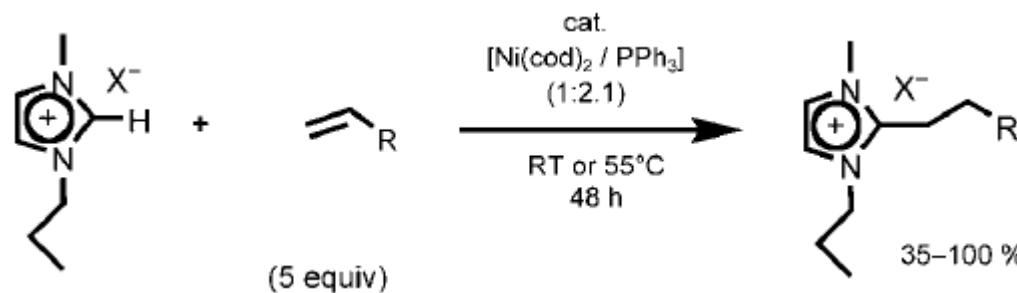
1. Early examples:



M. Dubeck, *et al.* *J. Am. Chem. Soc.*, **1963**, 85, 1544



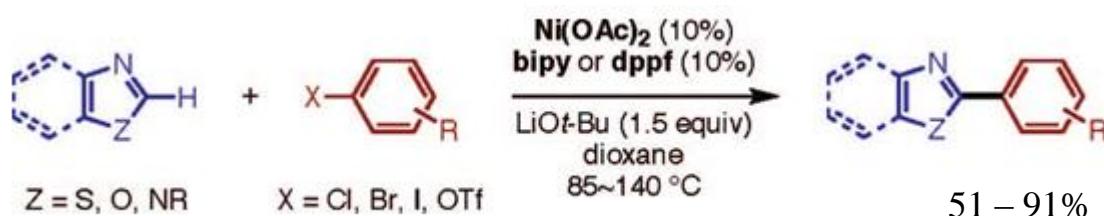
NHCs salts:



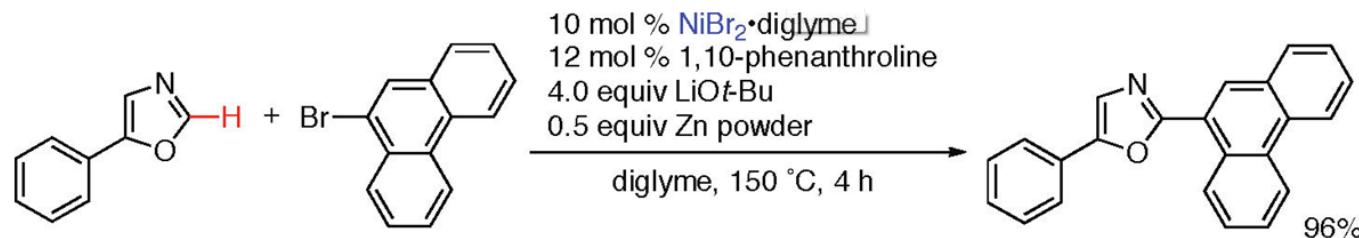
2. Active C-H bond

entry	heteroarene	alkyne	time (h)	product	yield (%) ^b
1		$\text{R}^1, \text{R}^2 = \text{CO}_2\text{Me}, \text{Me}$ (1c)	2a		4ca 85
2		$\text{CO}_2\text{Me}, \text{CH}_2\text{Ph}$ (1d)	2a		4da 57
3 ^c		$\text{CO}_2\text{Me}, \text{CH}_2\text{OMe}$ (1e)	120		4ea 84
4		$\text{C(O)Me}, \text{Me}$ (1f)	30		4fa 70
5		CHO, Me (1g)	6		4ga 91
6		$(E)\text{-CH=CHCO}_2\text{Me}, \text{Me}$ (1h)	10		4ha 88
7 ^d		Ph, Me (1i)	35		4ia 67
8		$\text{R} = \text{H}$ (1j)	2a		4ja 92
9		Cl (1k)	10		4ka 80
10		1l	2a		4la 94
11		1m	2a		4ma 94
12		$\text{X}, \text{Y} = \text{O}, \text{CH}$ (1n)	2a		4na 94
13		S, CH (1o)	24		4oa 47
14		O, N (1p)	8		4pa 89
15		1q	2a		4qa 89
16		$\text{R}^1 \equiv \text{R}^2$			53 – 88%
17 ^e		$\text{Me}, i\text{-Pr}$ (2b)	6		4bb 97
18 ^f		Me, SiMe_3 (2c)	40		4bc 74
		Ph, SiMe_3 (2d)	35		4bd 67

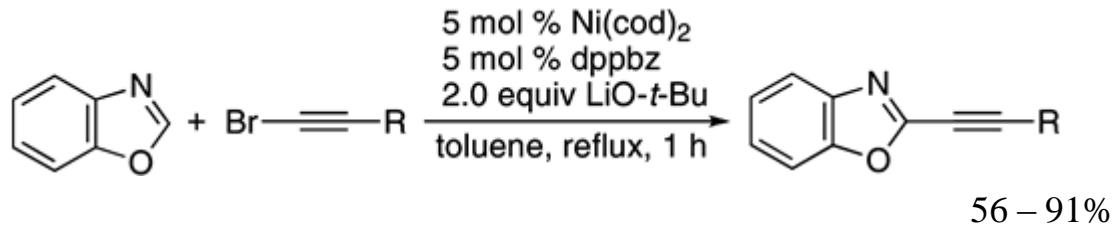
a. Azoles type C-H activation:



K. Itami, *et al. Org. Lett.* **2009**, *11*, 1733.

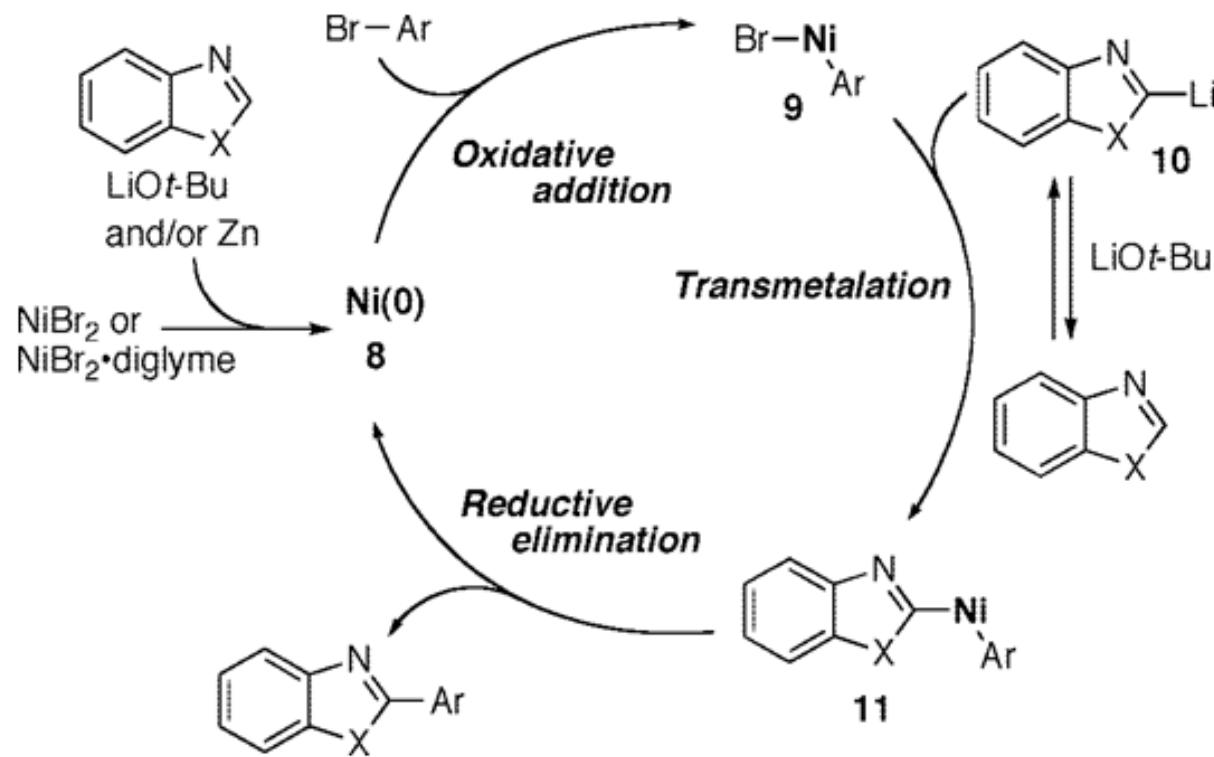


M. Miura, *et al. Org. Lett.* **2009**, *11*, 1737.

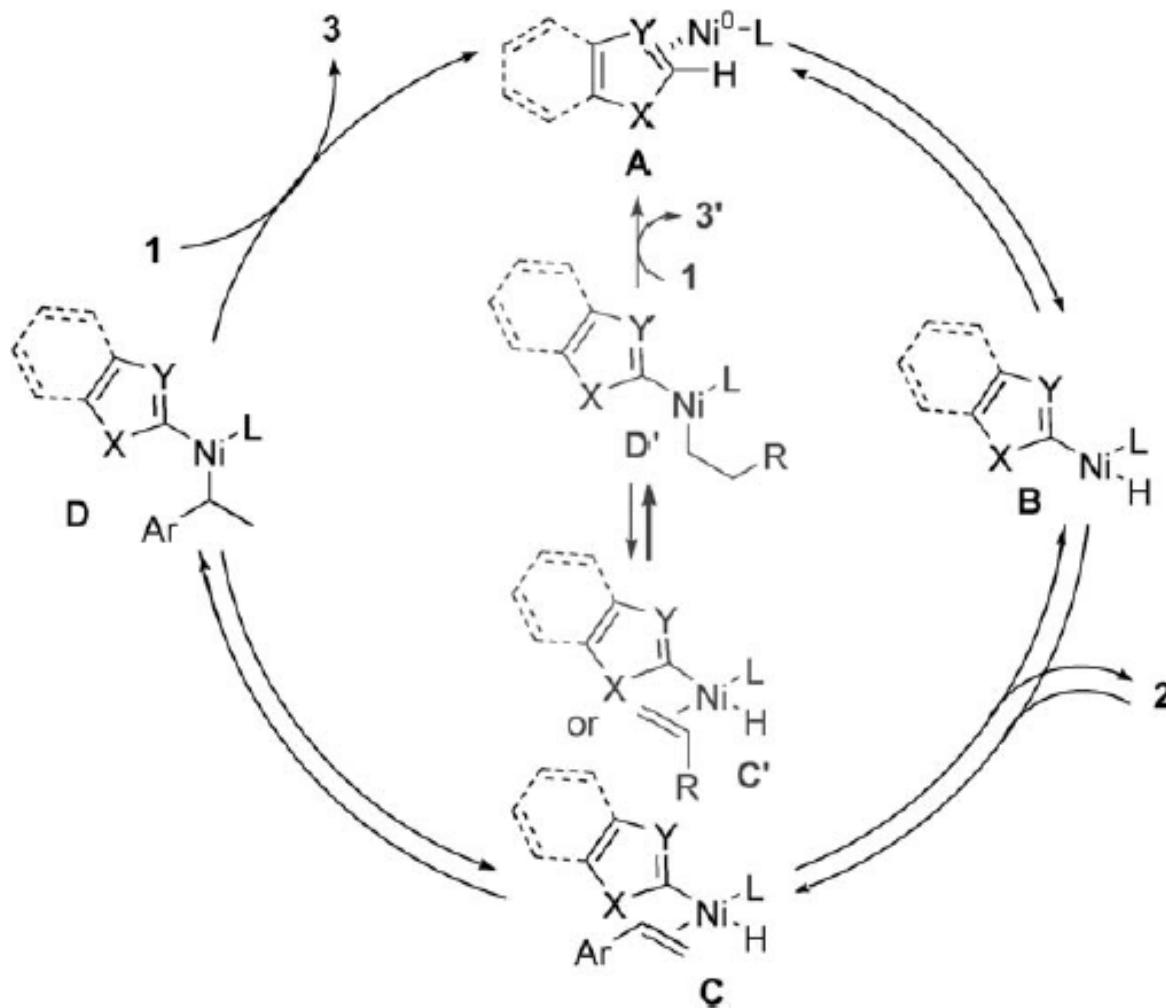


M. Miura, *et al. Org. Lett.* **2009**, *11*, 4156.

a. Azoles type C-H activation:

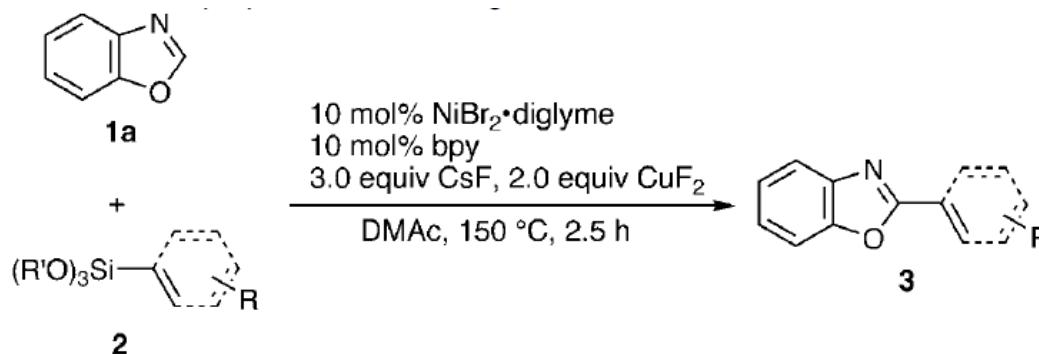


a. Azoles type C-H activation:

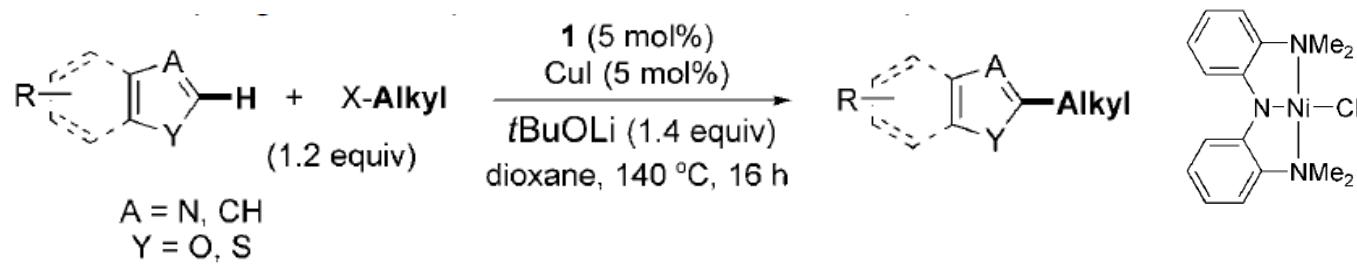


T. Hiyama, et al. *Angew. Chem. Int. Ed.*, **2010**, *49*, 4451

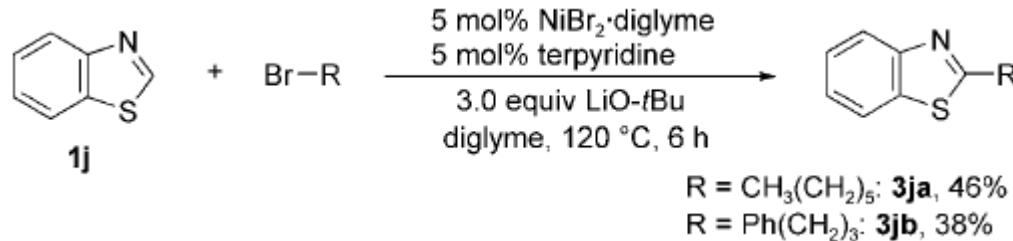
a. Azoles type C-H activation:



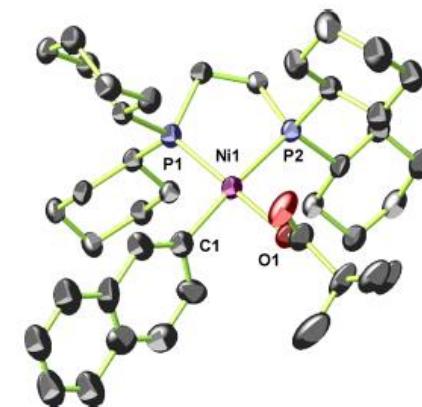
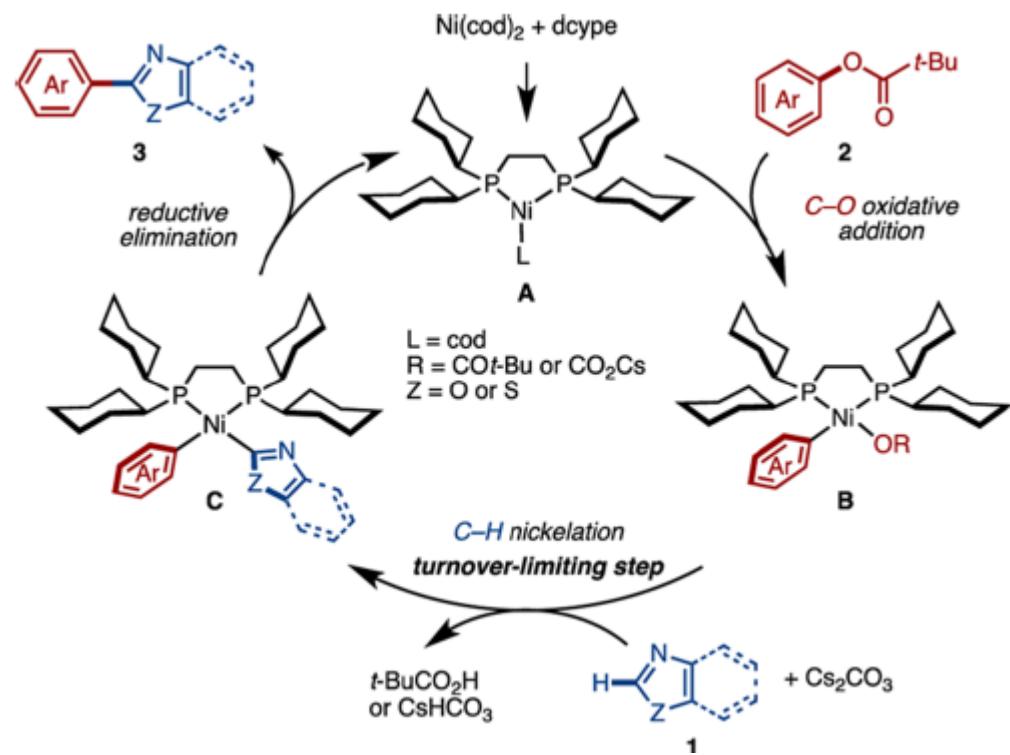
M. Miura, et al. *Angew. Chem. Int. Ed.*, **2010**, *49*, 2202



X. Hu, et al. *Angew. Chem. Int. Ed.*, **2010**, *49*, 3061

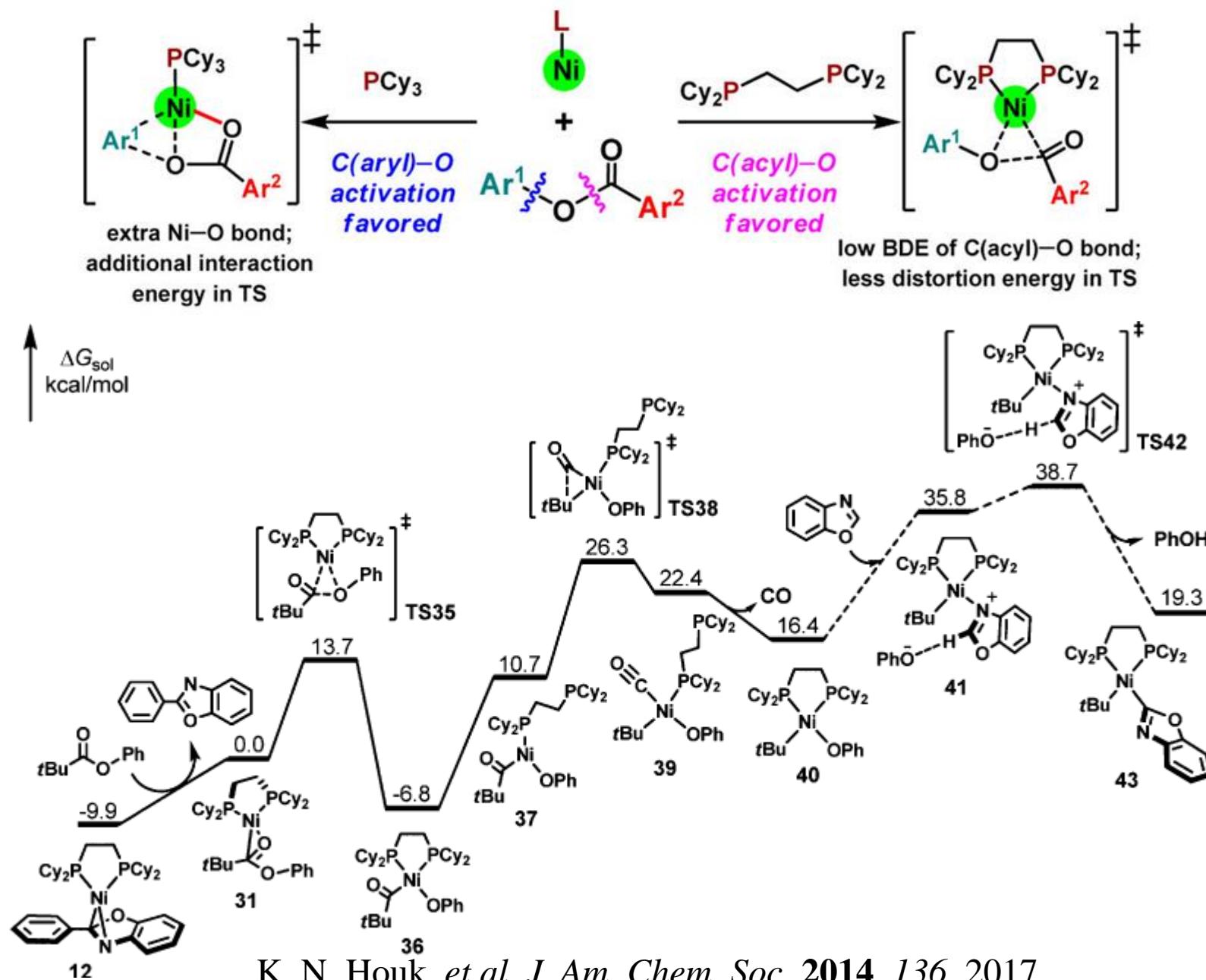


a. Azoles type C-H activation:

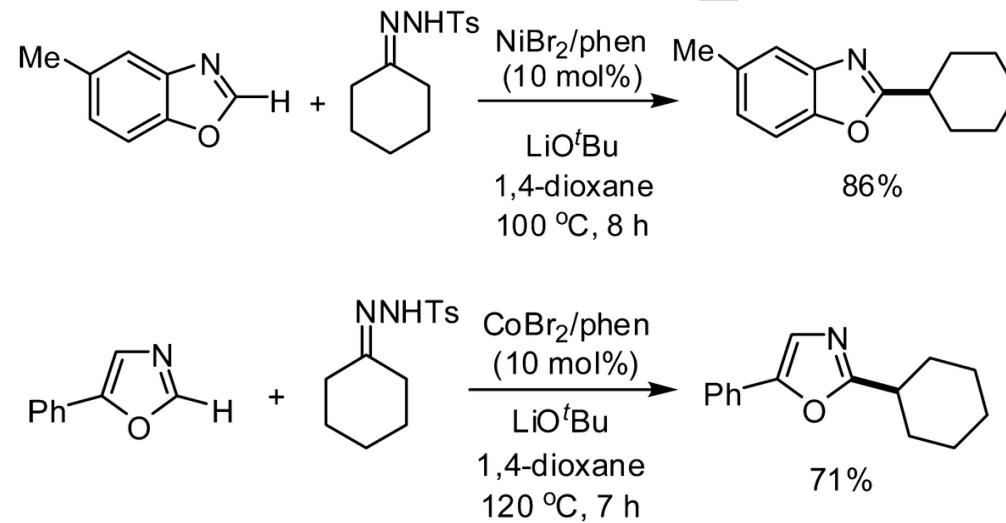


K. Itami, et al. *J. Am. Chem. Soc.* **2011**, *134*, 169.

J. Yamaguchi, A. Lei, K. Itami, et al. *J. Am. Chem. Soc.* **2013**, *135*, 16384.

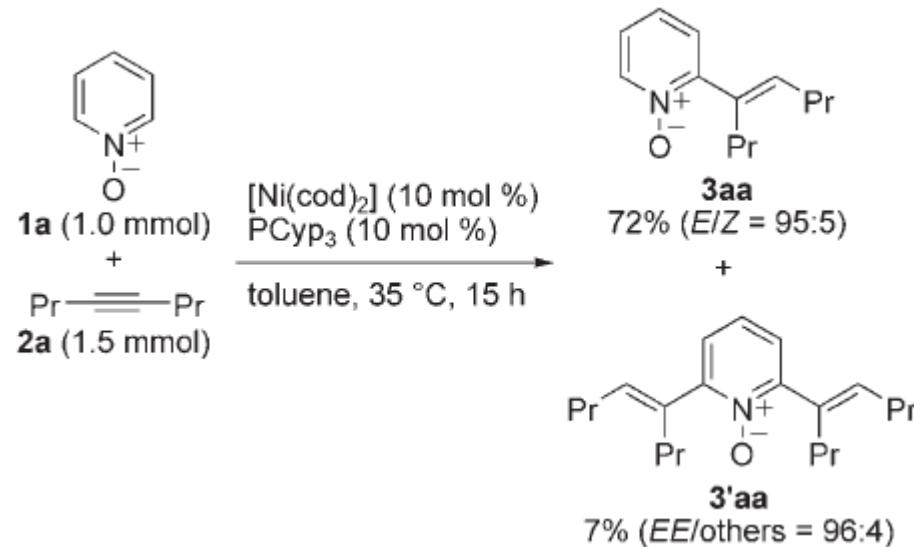


Azoles type C-H activation:



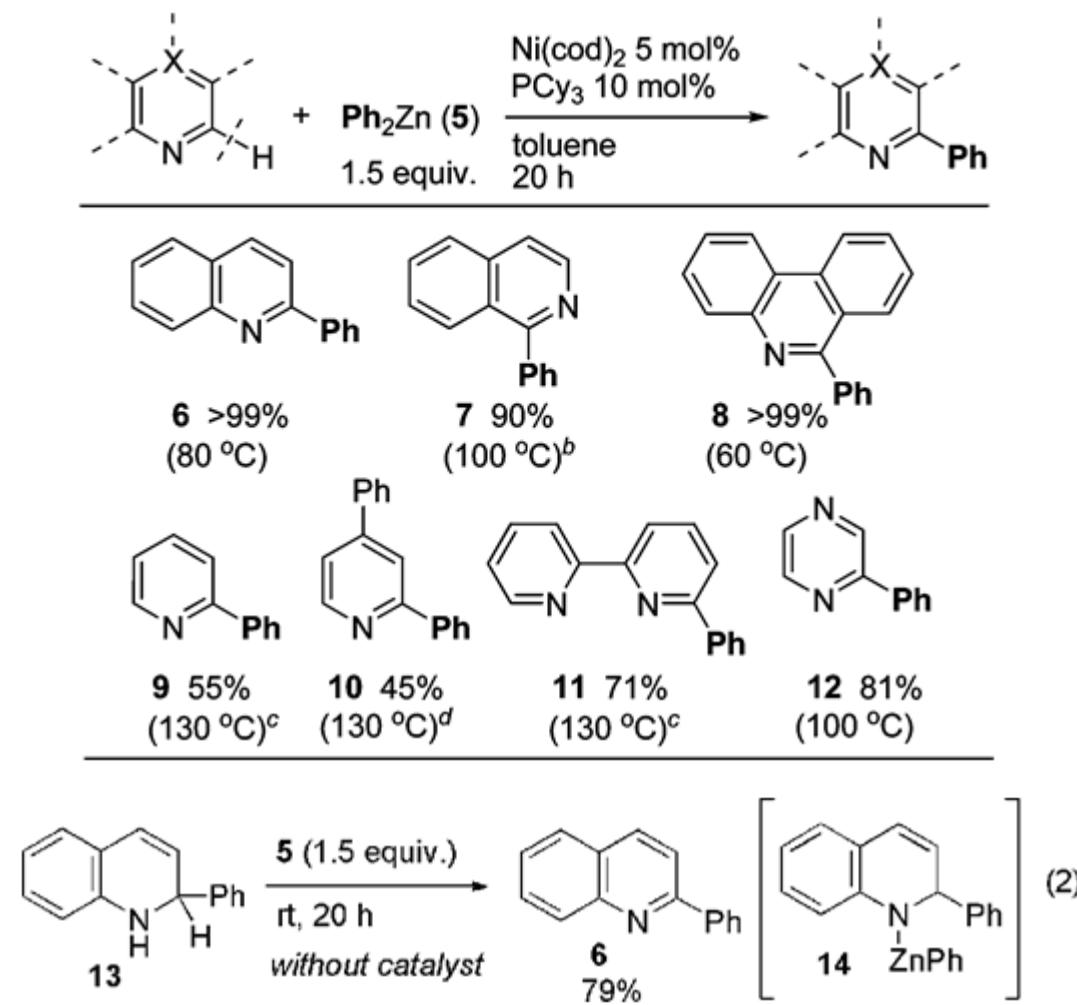
M. Mirua, *et al. Angew. Chem., Int. Ed.* **2012**, *51*, 775.

Other active C-H: Pyridine-N-oxides



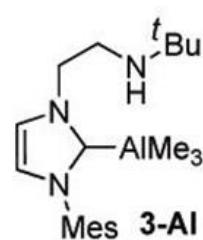
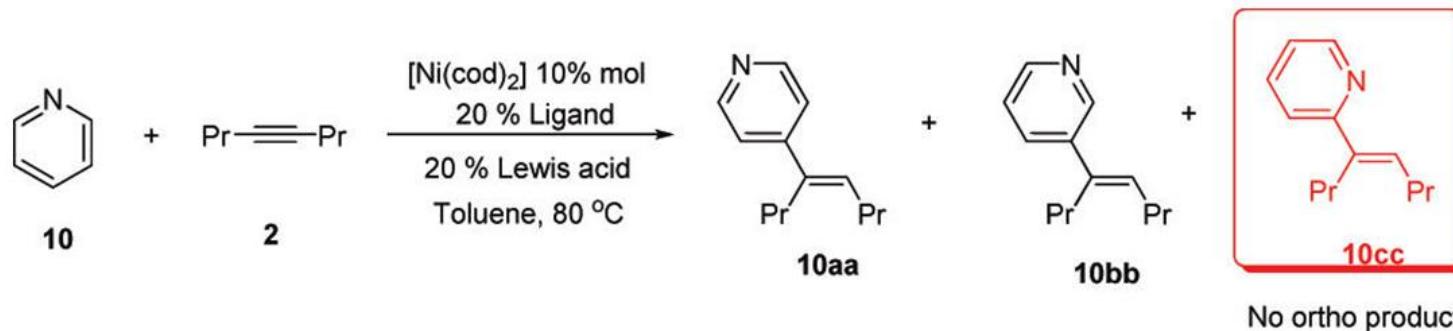
T. Hiyama, *et al. Angew. Chem. Int. Ed.*, **2007**, *46*, 8872

Other active C-H: Pyridine

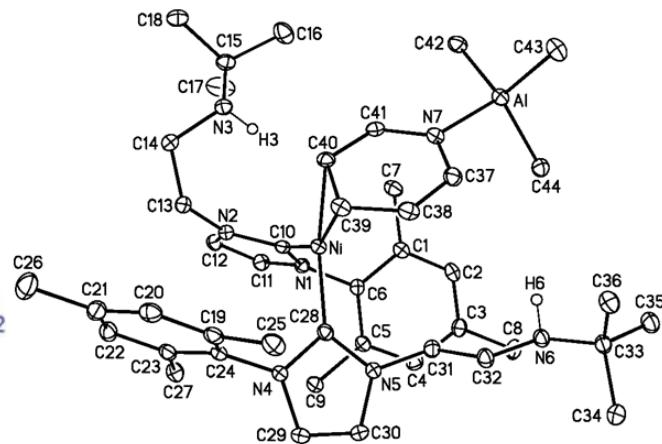
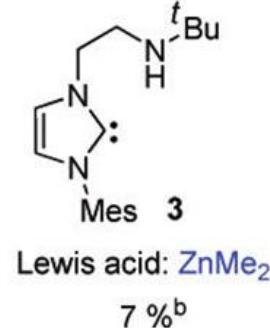
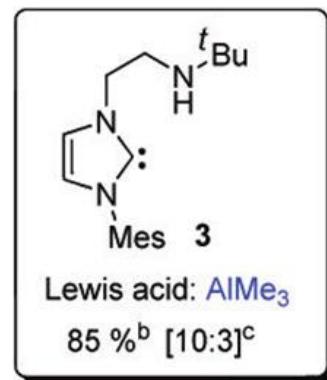


N. Chatani, et al. *J. Am. Chem. Soc.* **2009**, *131*, 12070.

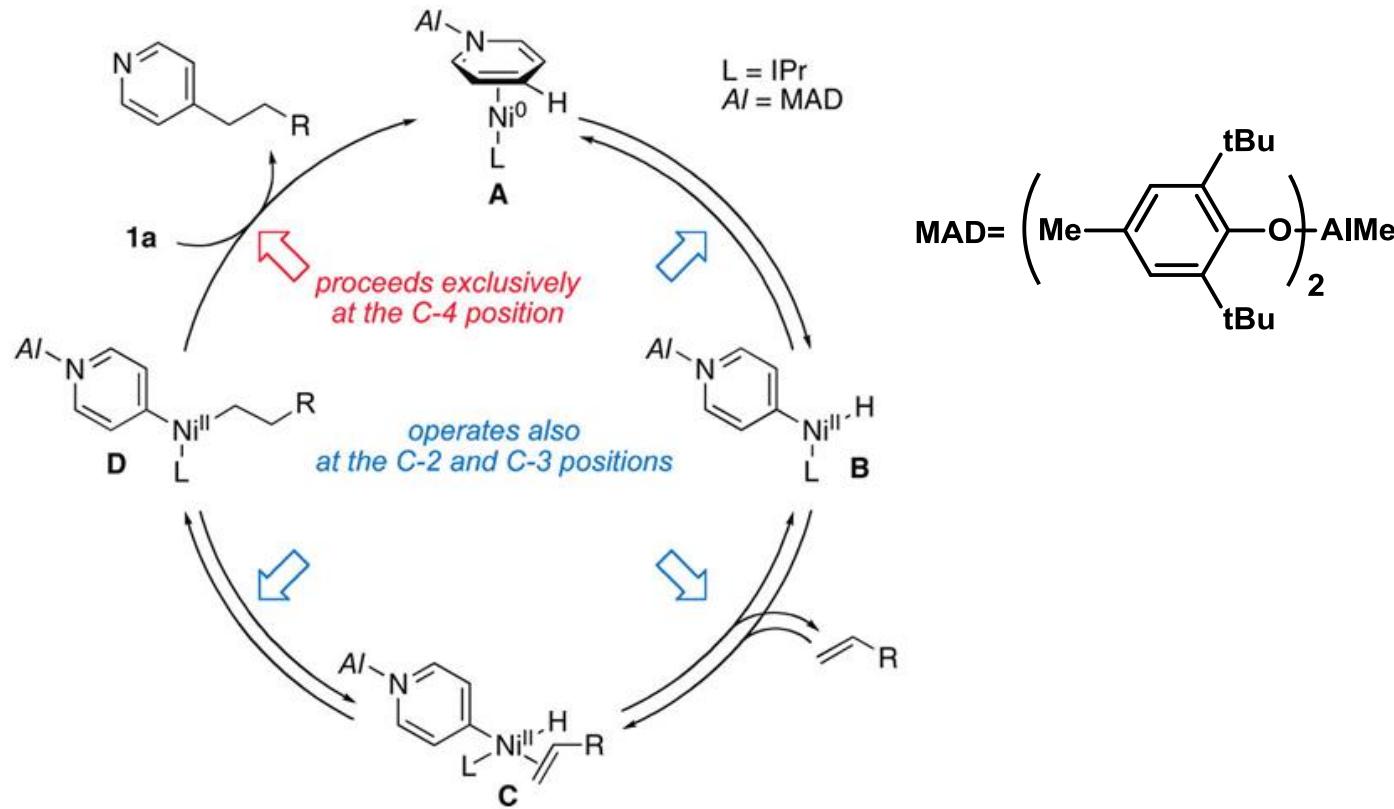
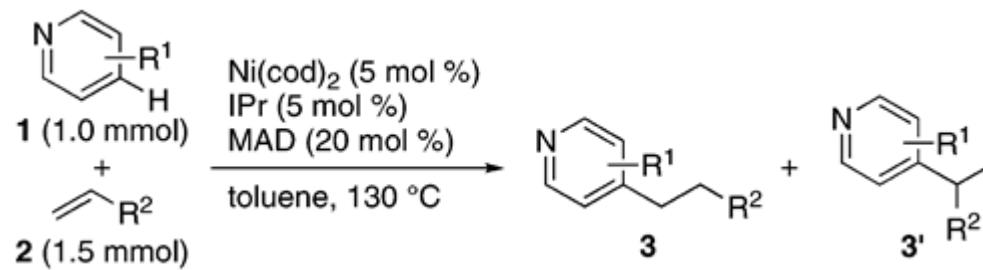
Other active C-H: Pyridine



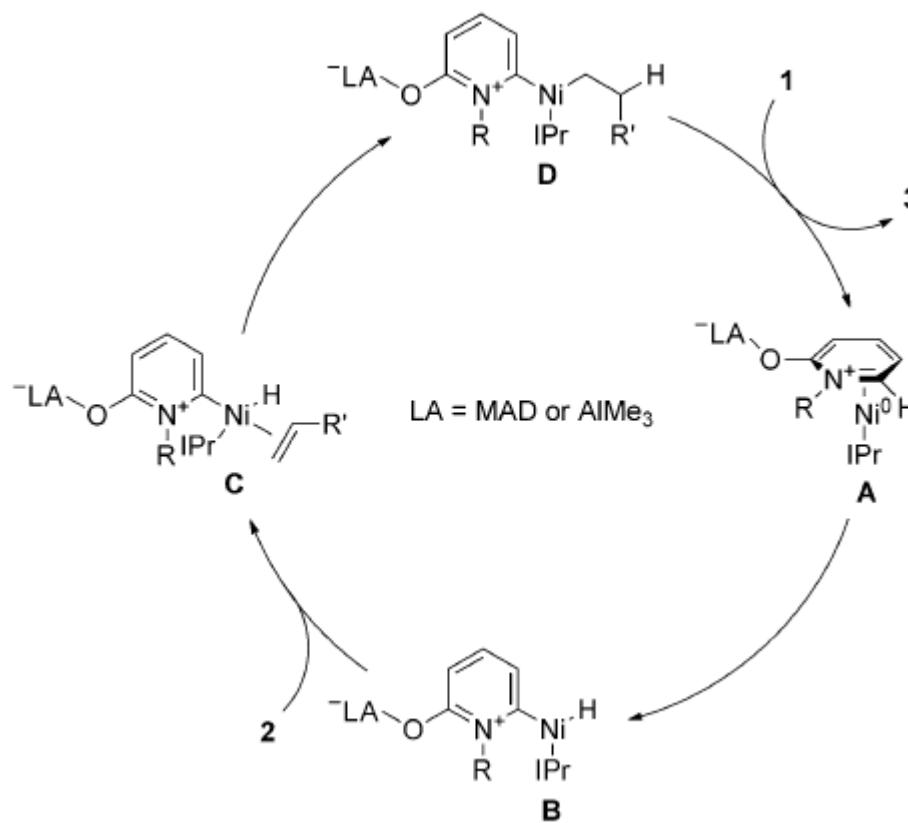
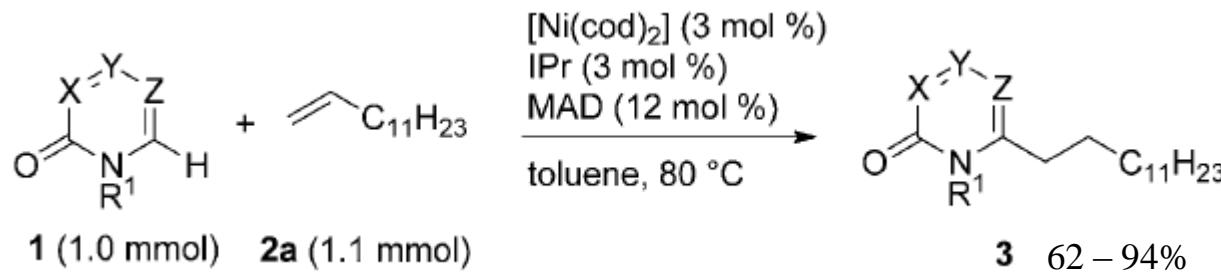
83 %^b



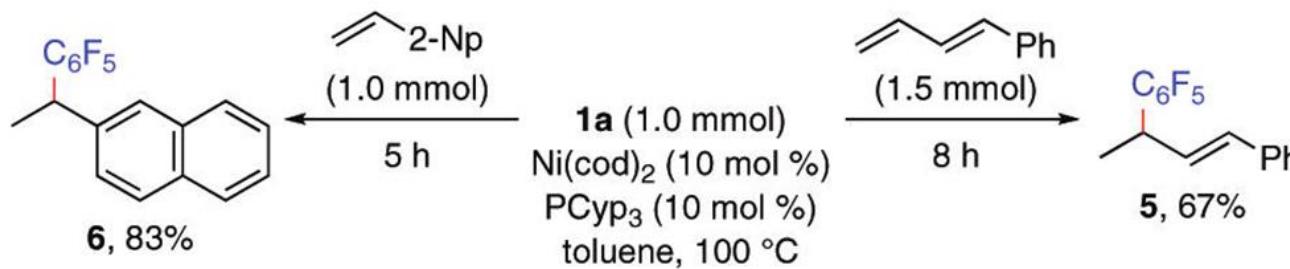
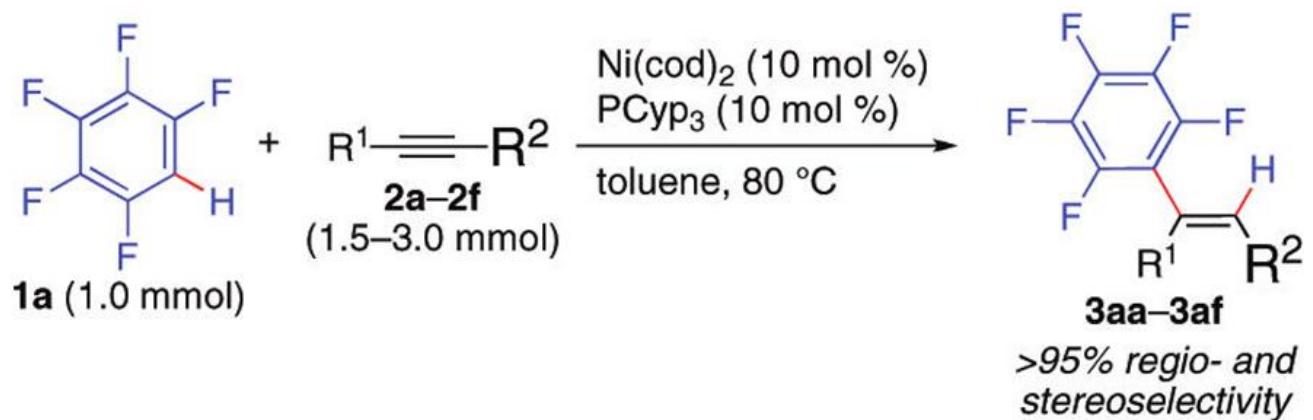
Other active C-H: Pyridine



Other active C-H: Pyridone

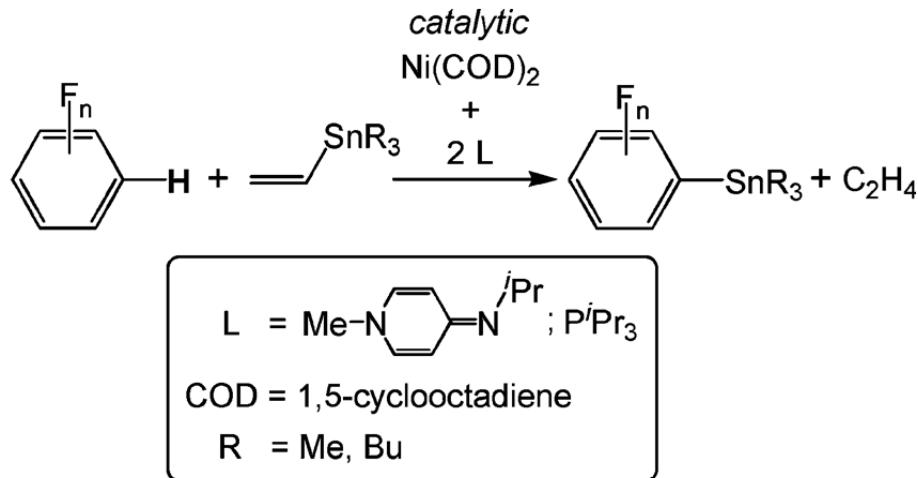


Other active C-H: Fluoroarenes

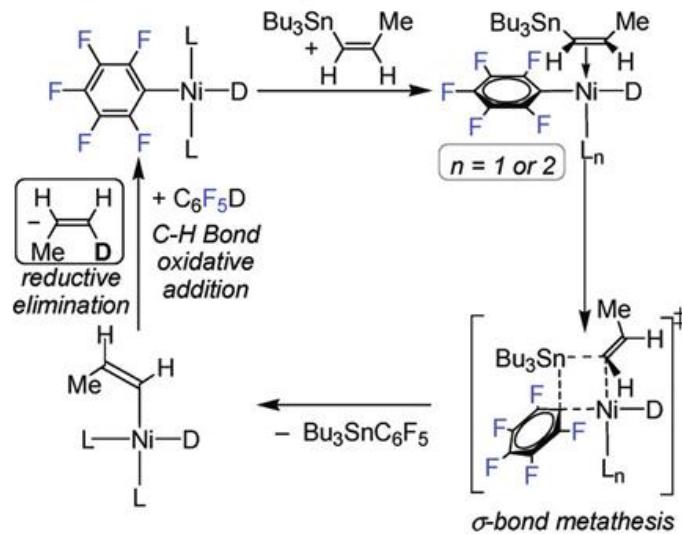


T. Hiyama, et al. *J. Am. Chem. Soc.* **2008**, *130*, 16170.

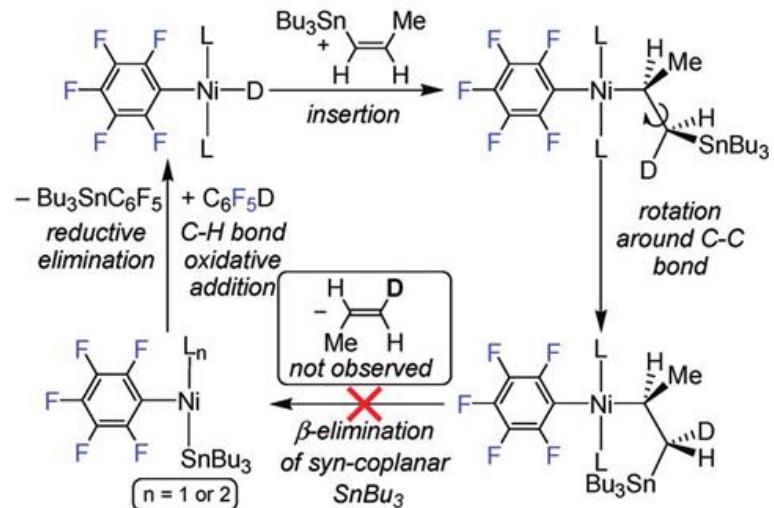
Other active C-H: Fluoroarenes



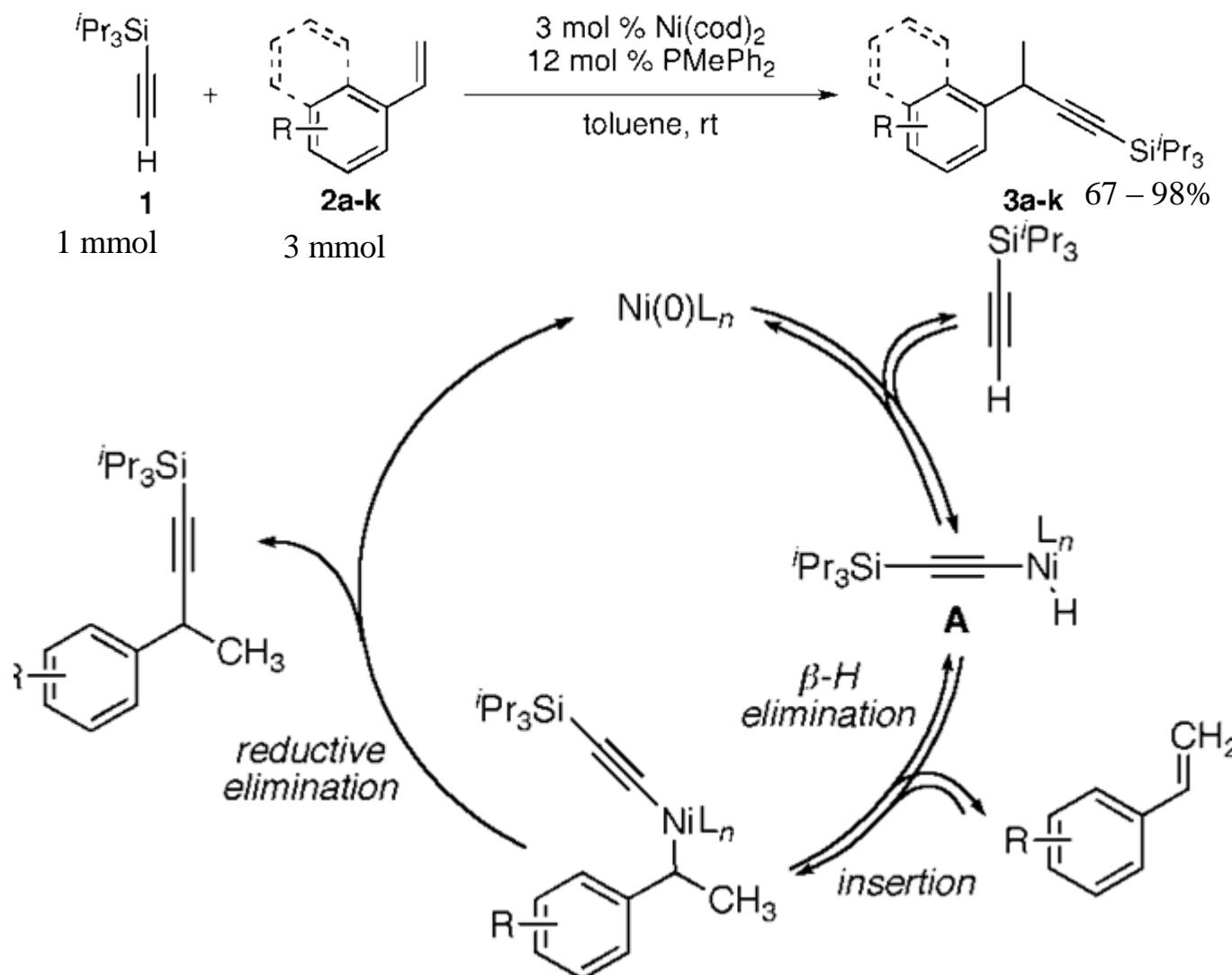
Mechanism A: σ -bond metathesis



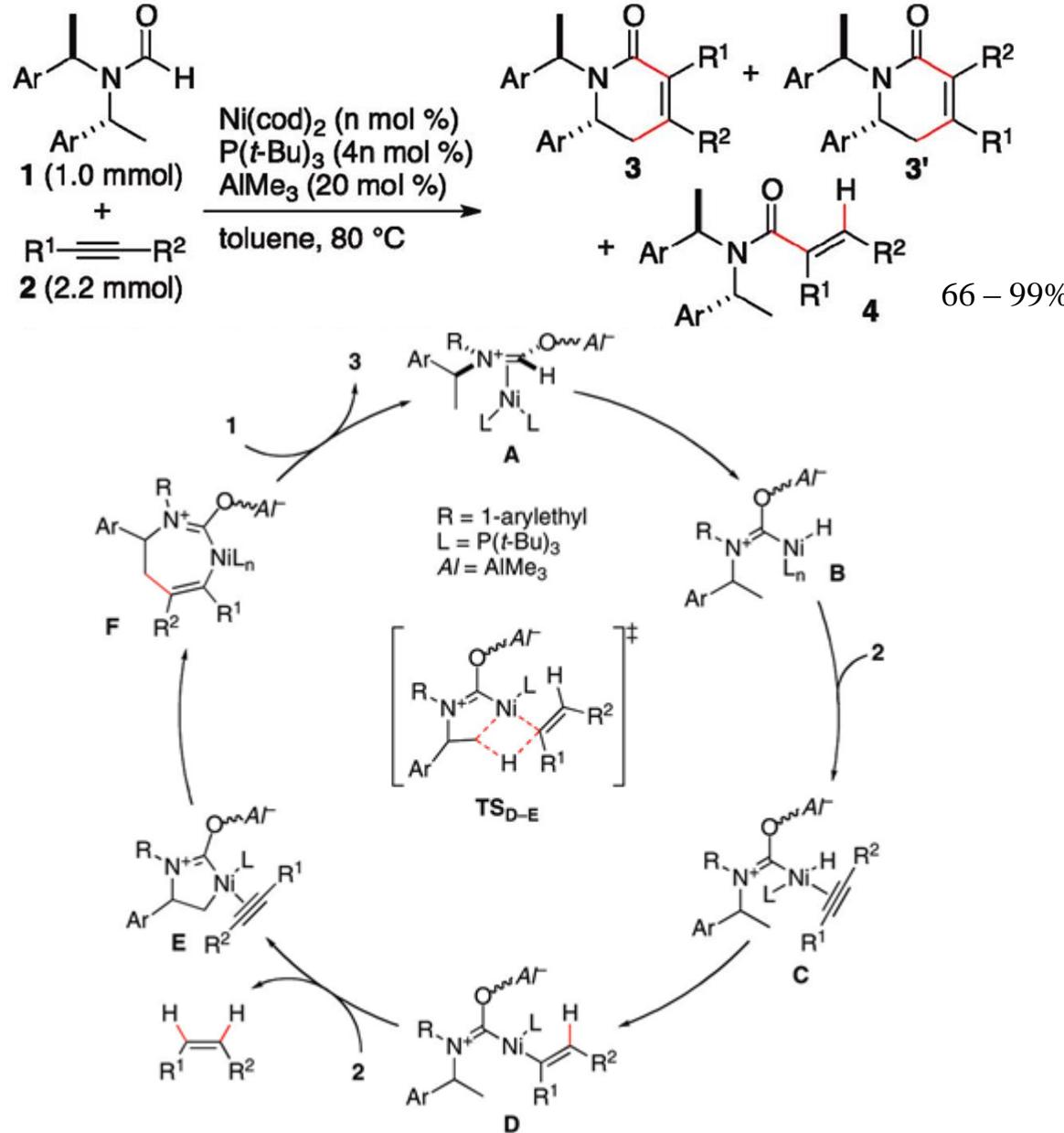
Mechanism B: insertion/ β -elimination

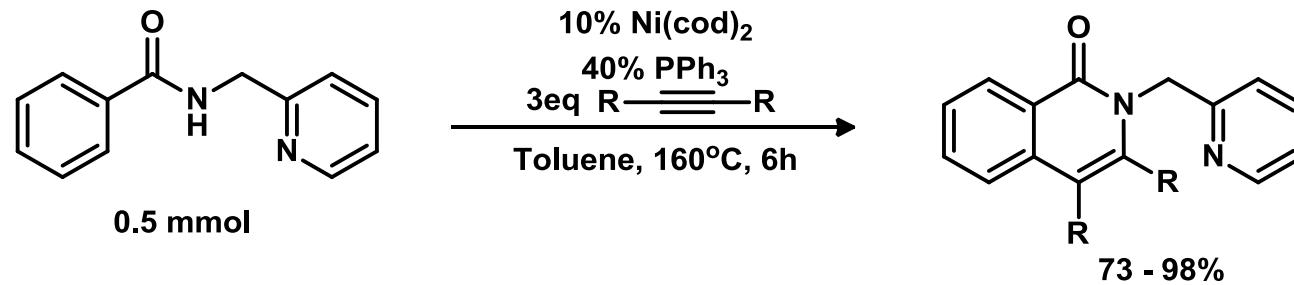


Other active C-H: Terminal alkyne

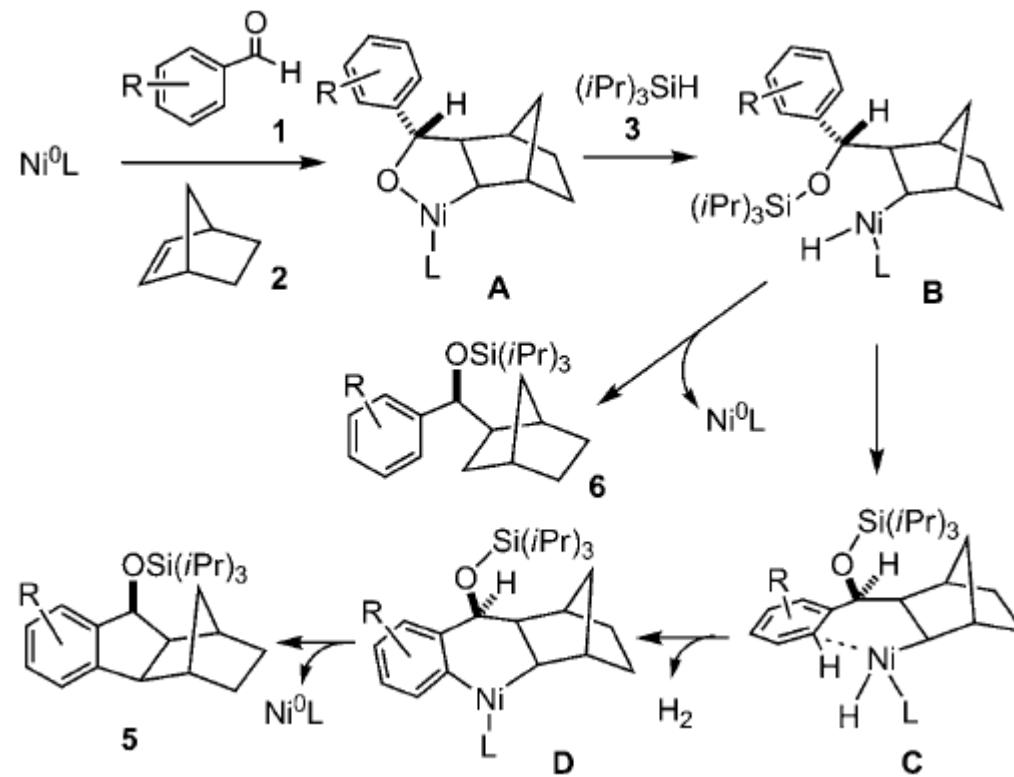
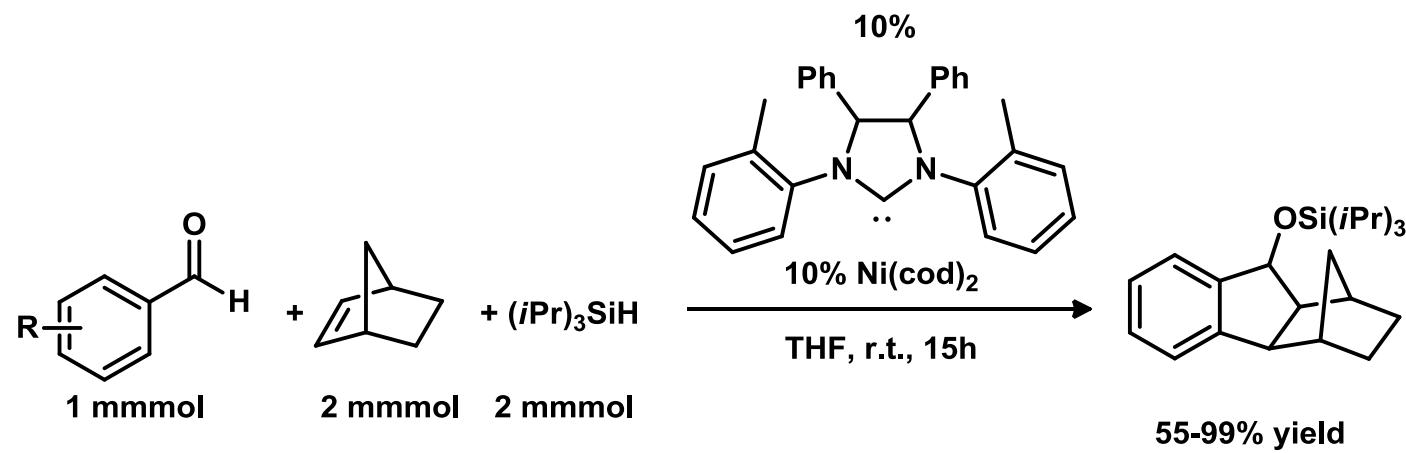


3. Directed C-H activation

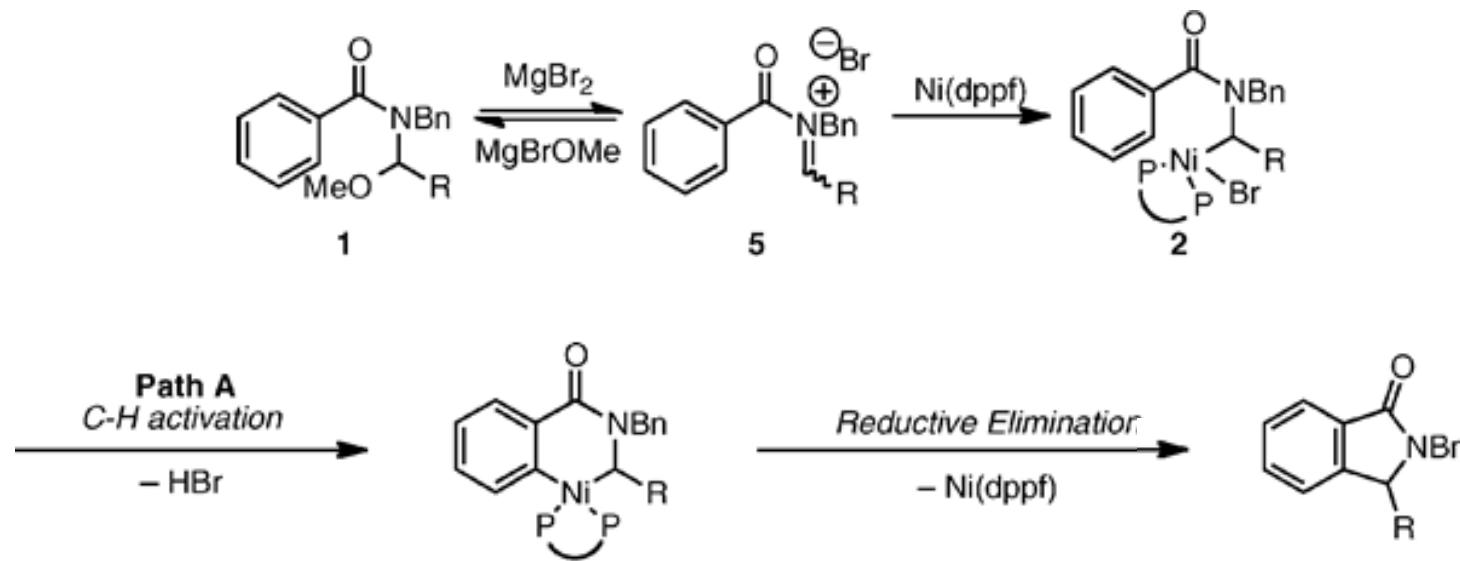
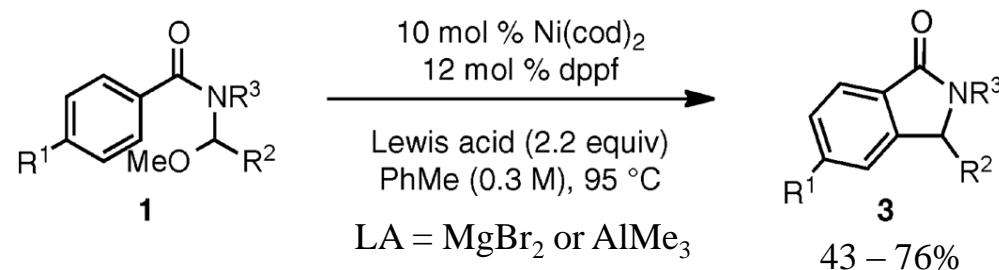




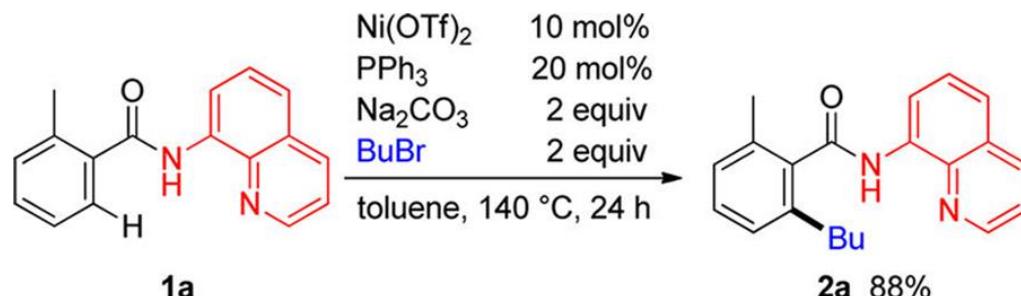
N. Chatani, *et al.* *J. Am. Chem. Soc.* **2011**, *133*, 4952.



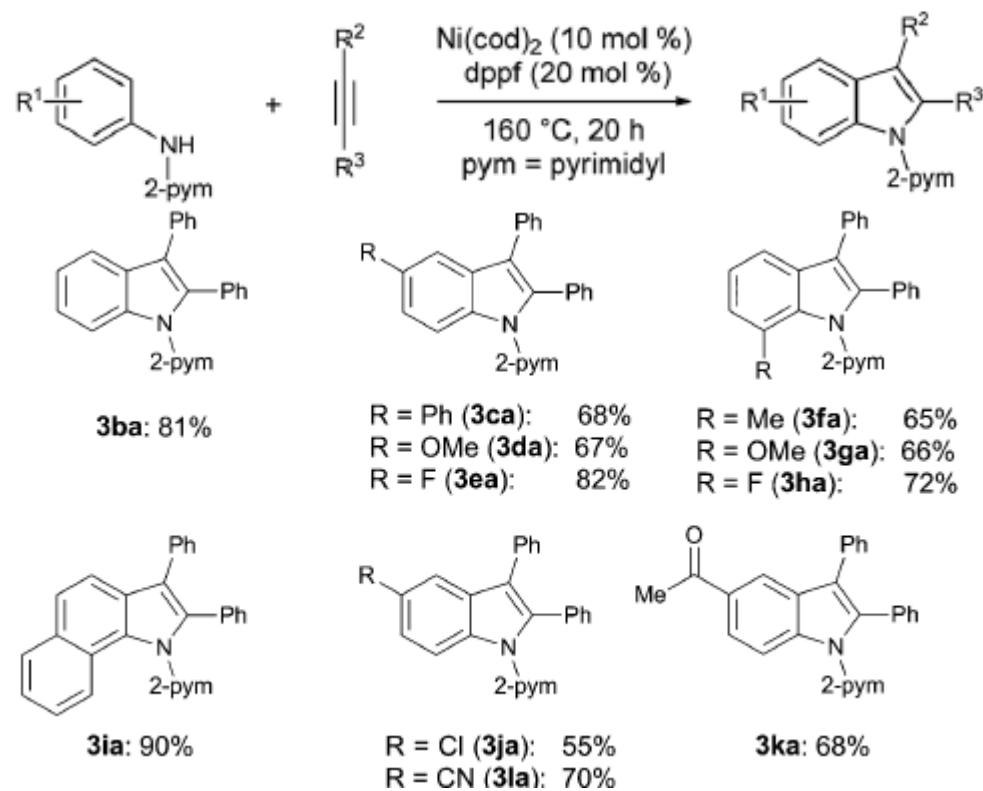
S. Fukuzawa, et al. *Angew. Chem., Int. Ed.* **2011**, *50*, 5869.

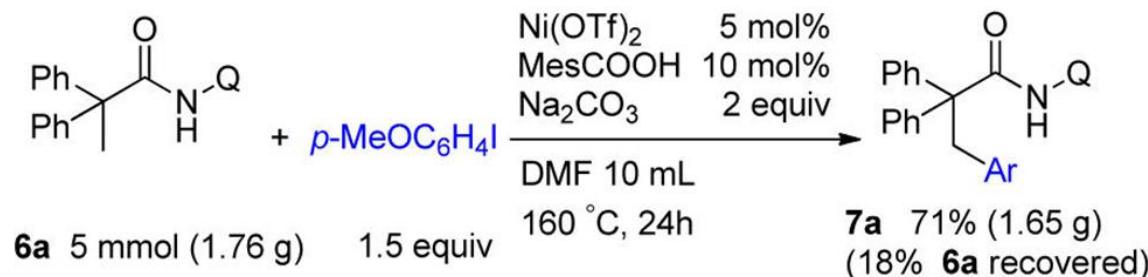


M. P. Watson, *et al. Org. Lett.* **2011**, *11*, 3490.

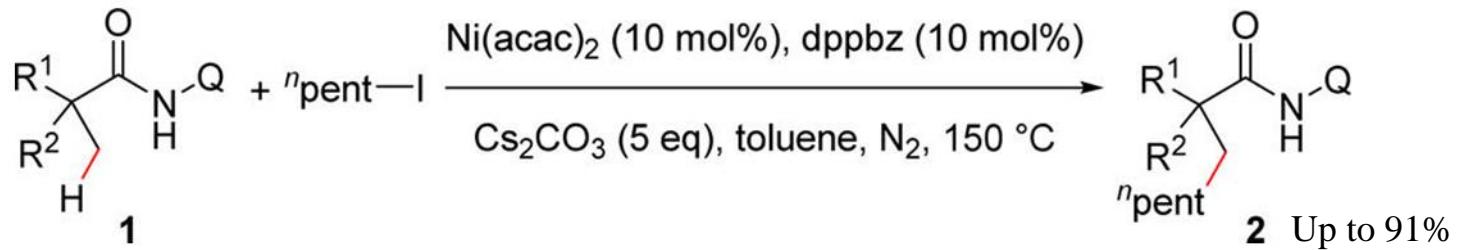


N. Chatani, *et al.* *J. Am. Chem. Soc.* **2013**, *135*, 5308.

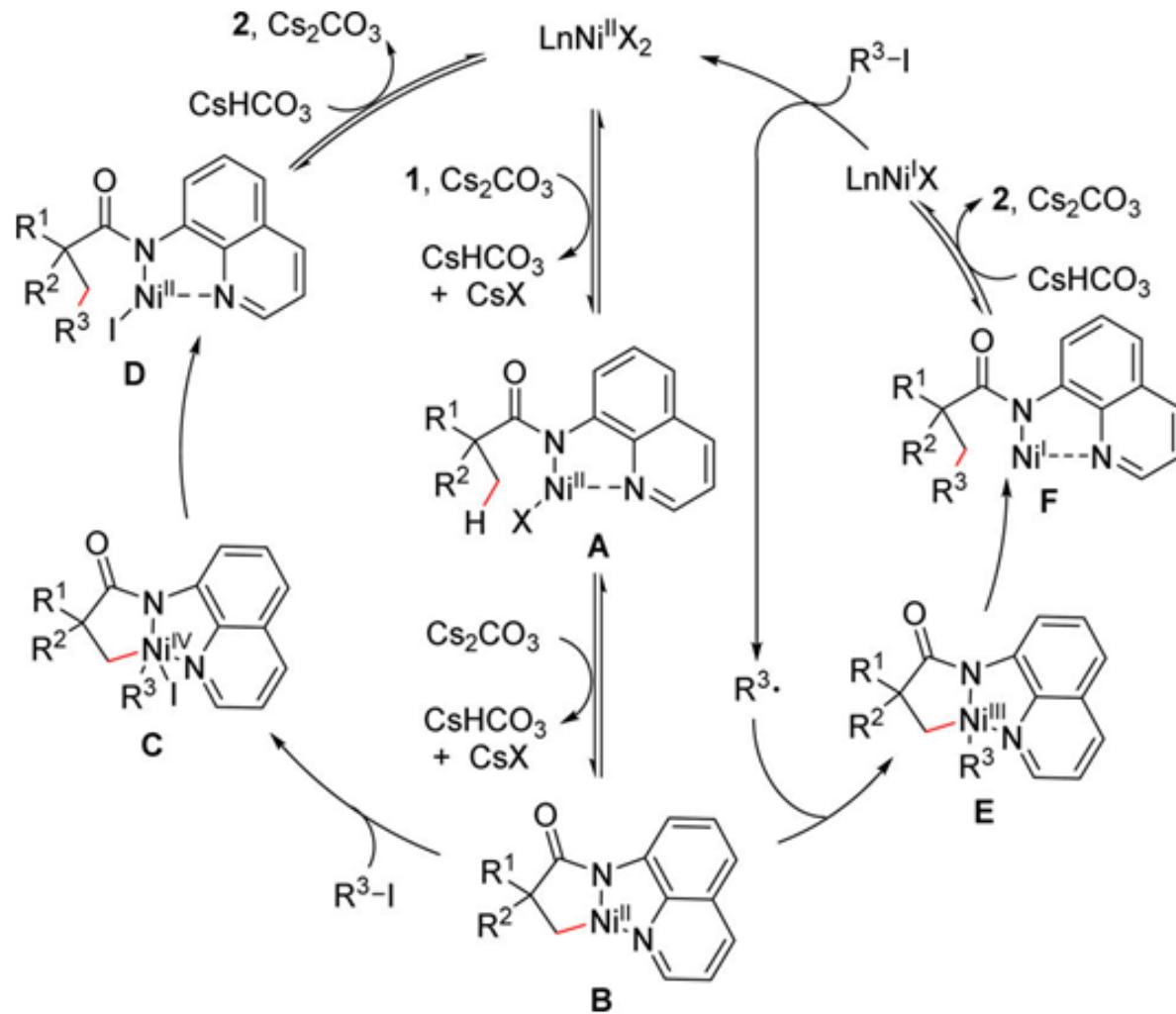


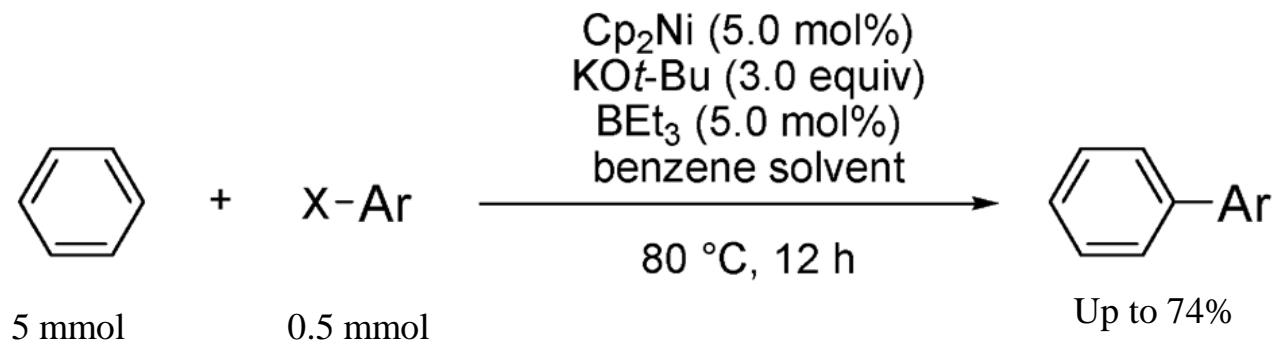


N. Chatani, *et al.* *J. Am. Chem. Soc.* **2014**, *136*, 898.



H. Ge, *et al.* *J. Am. Chem. Soc.* **2014**, *136*, 1789.





Summary

- a.** Nickel catalyzed C-H activation of active C-H bond, and inert C-H bond by Chelation assist.
- b.** Nickel show different and unique reactivity
- c.** Possible to find a new reaction pattern

**Thanks for Your
Attention !**