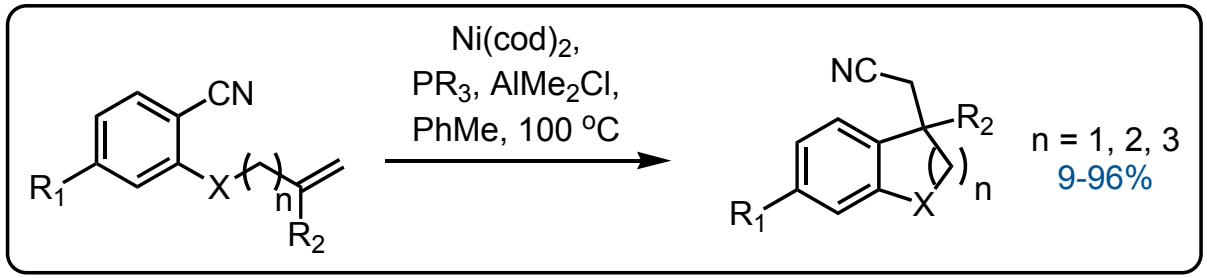
Intramolecular Arylcyanation of Alkenes Catalyzed by Nickel/$AlMe_2Cl$

Y. Nakao, S. Ebata, A. Yada, T. Hiyama, M. Ikawa, S. Ogoshi

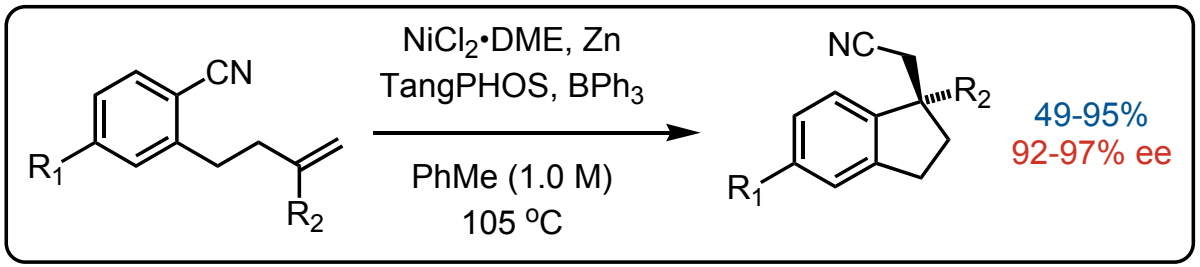
J. Am. Chem. Soc. **2008**, ASAP



Asymmetric Intramolecular Arylcyanation of Unactivated Olefins via C-CN Bond Activation

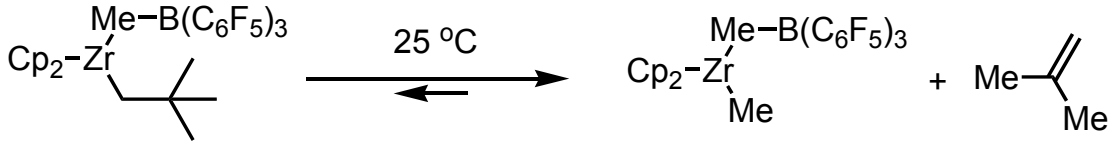
M. P. Watson and E. N. Jacobsen

J. Am. Chem. Soc. **2008**, *130*, 12594



Stoichiometric C-C Activation

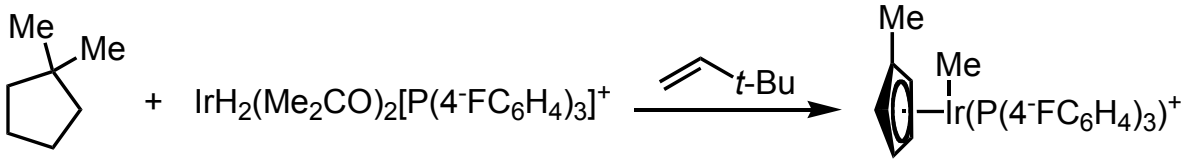
- β-Carbon Elimination



A. D. Horton *Organometallics* **1996**, 15, 2675

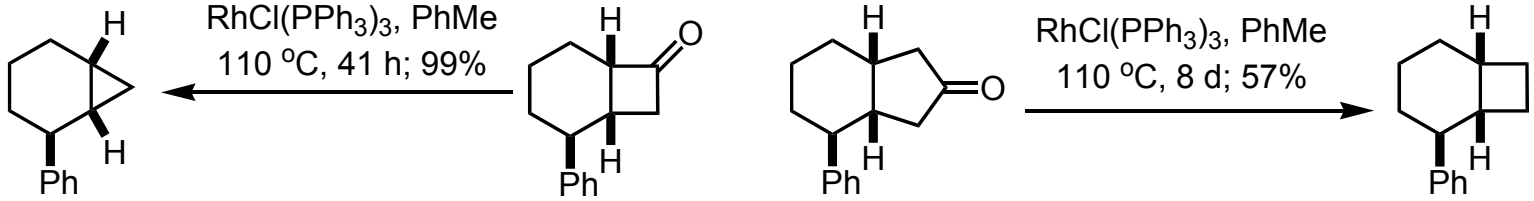
see also Ziegler-Natta polymerization with cationic d^0 (Zf, Hf) complexes

- Aromatization as a Driving Force in C-C Bond Cleavage



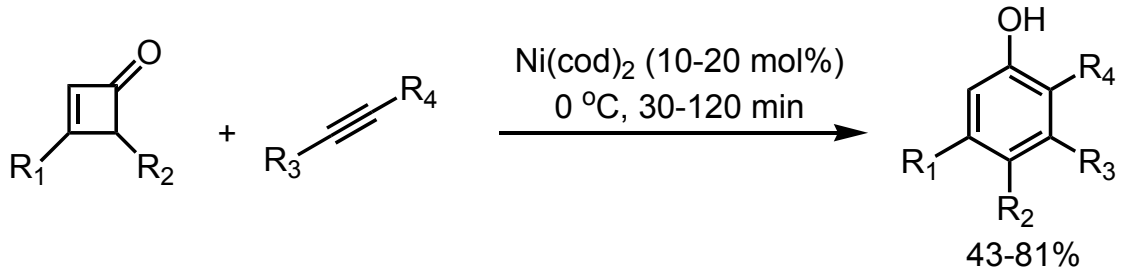
R. H. Crabtree, R. P. Dion, D. J. Gibboni, D. V. McGrath, E. M. Holt *J. Am. Chem. Soc.* **1986**, *108*, 7222

- CO Extrusion



M. Murakami, H Amii, Y. Ito *Nature* **1994**, *370*, 540

Selected Catalytic C-C Activation Reactions



43-81%

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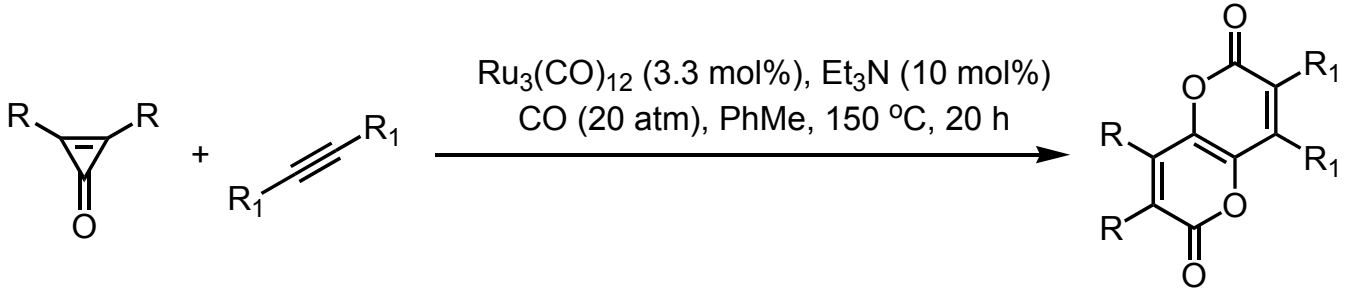

54-82%

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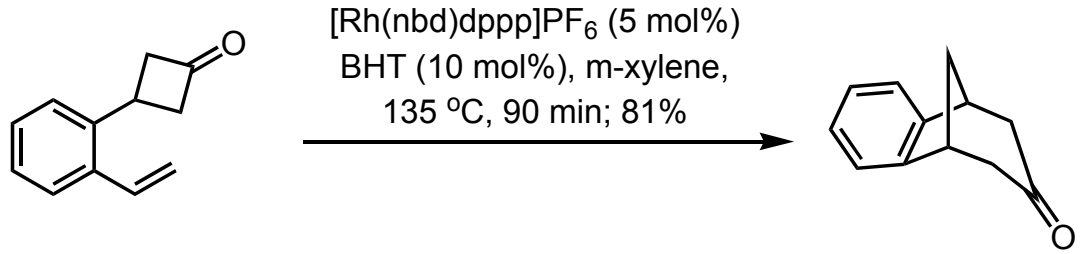

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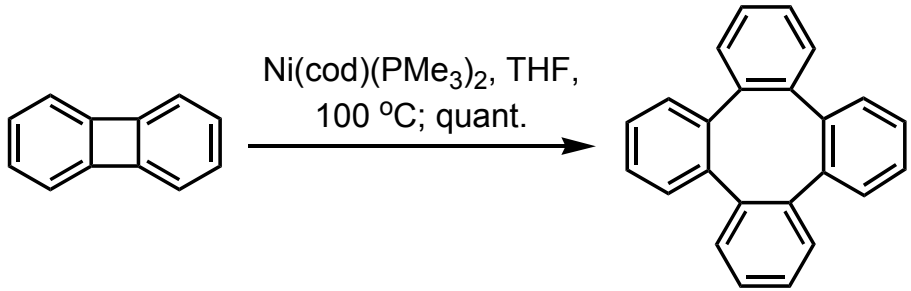
Selected Catalytic C-C Activation Reactions



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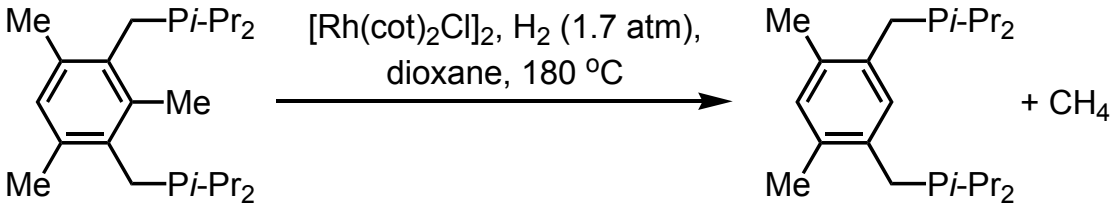
J. Organomet. Chem. **1990**, *382*, 191



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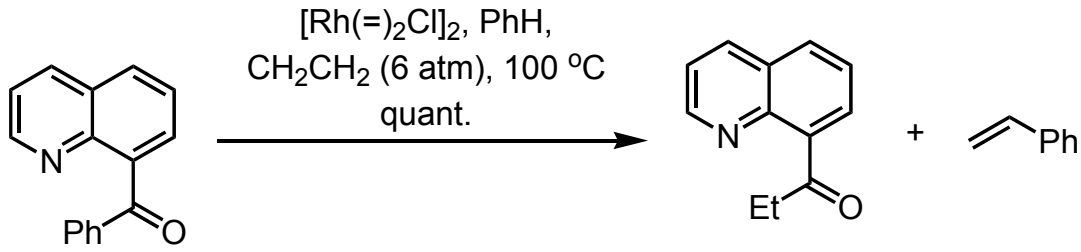

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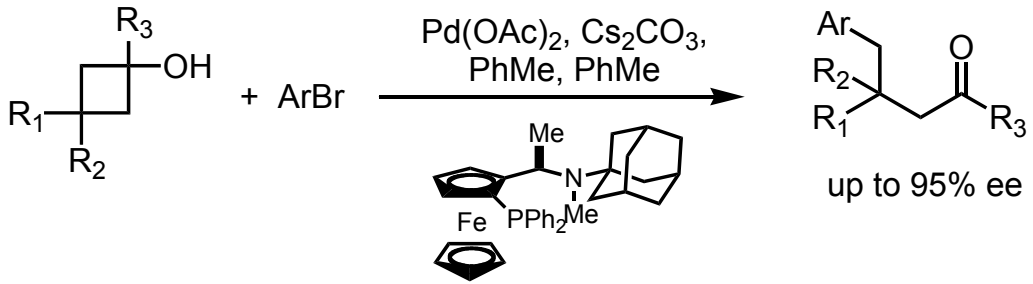
Enantioselective Catalytic C-C Activation



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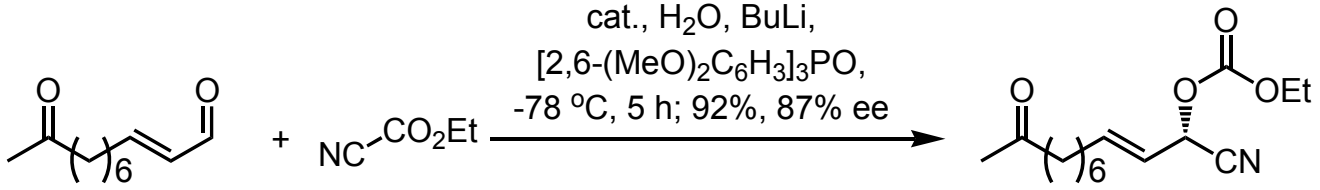

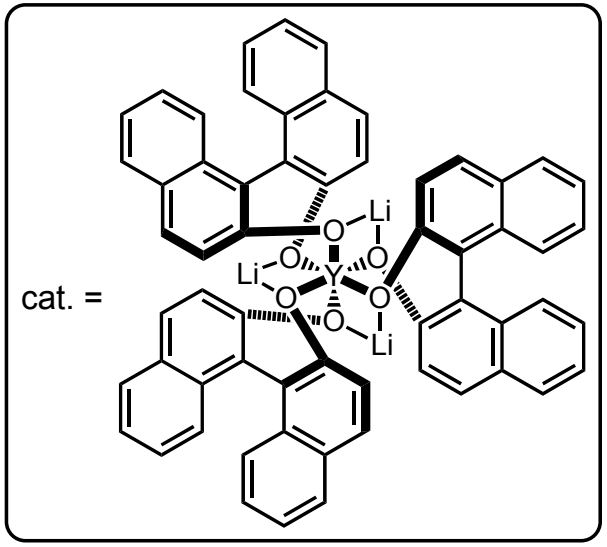

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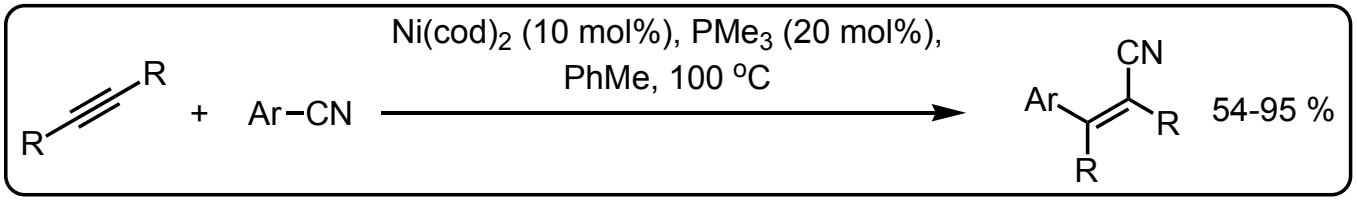
J. Am. Chem. Soc. **2005**, *127*, 3414

C-CN Activation



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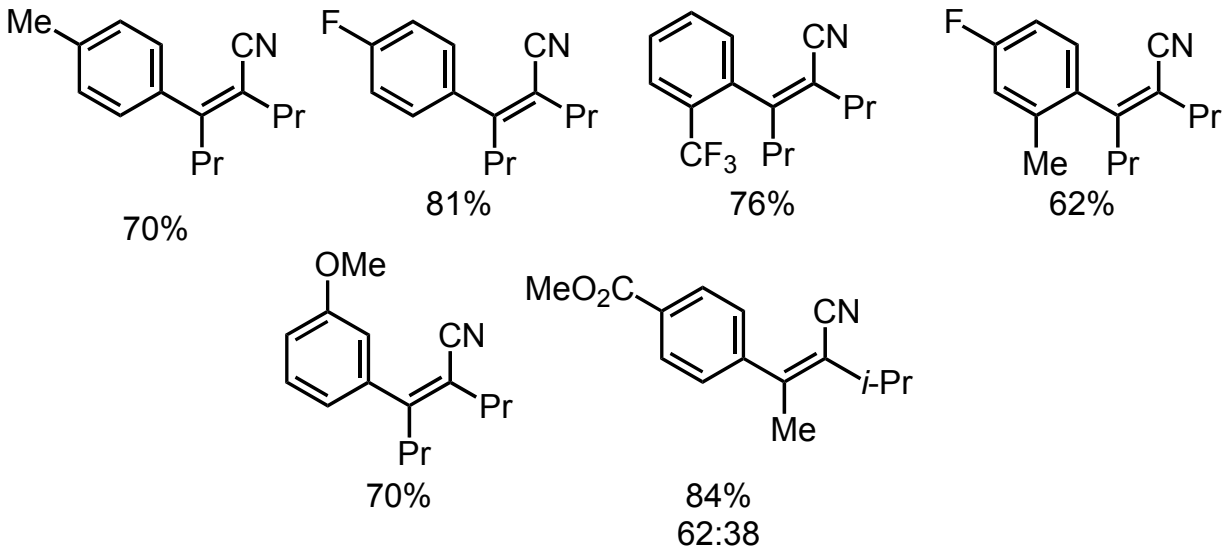
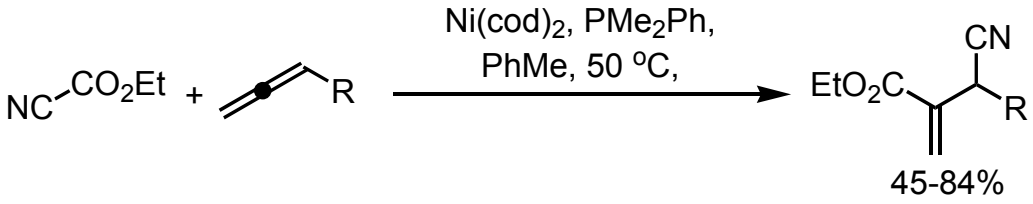


Nakao, Oda, Hiyama *J. Am. Chem. Soc.* **2004**, *126*, 13904

Significant rate acceleration was observed with Lewis acids ($AlMe_3$, BPh_3, $AlMe_2Cl$)
Y. Nakao, A. Yada, S. Ebata, T. Hiyama *J. Am. Chem. Soc.* **2007**, *129*, 2428

C-CN Activation



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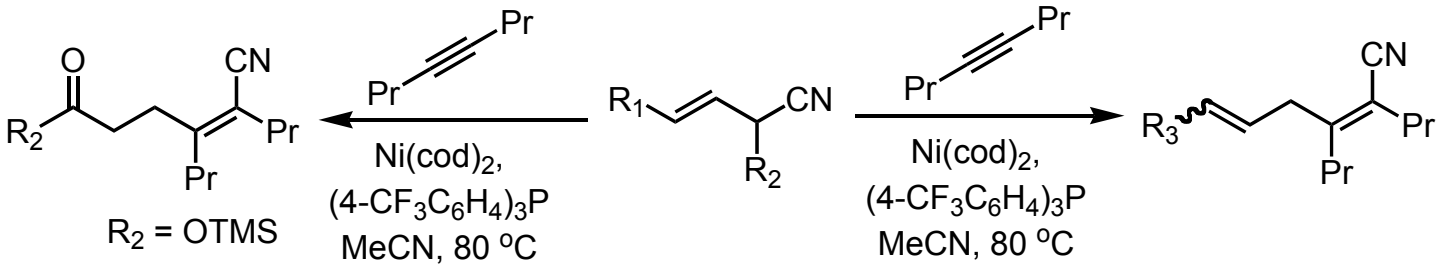
J. Am. Chem. Soc. **2006**, *128*, 7420



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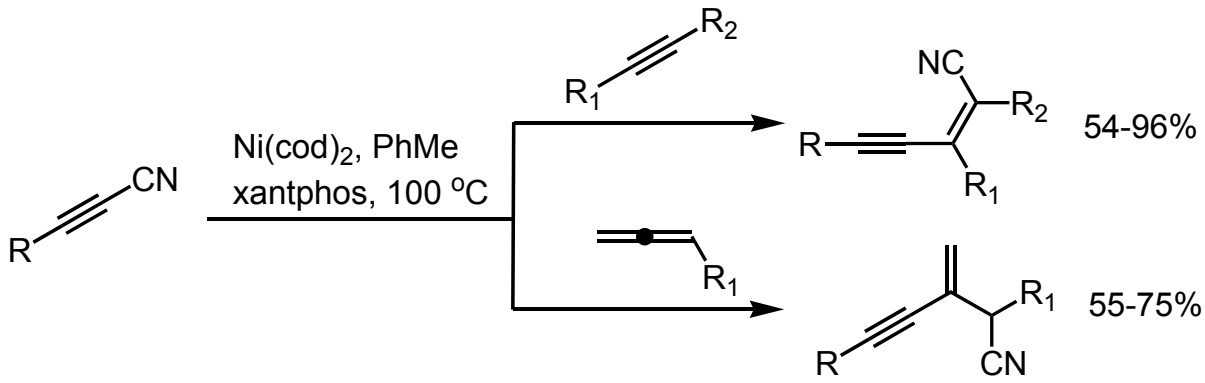
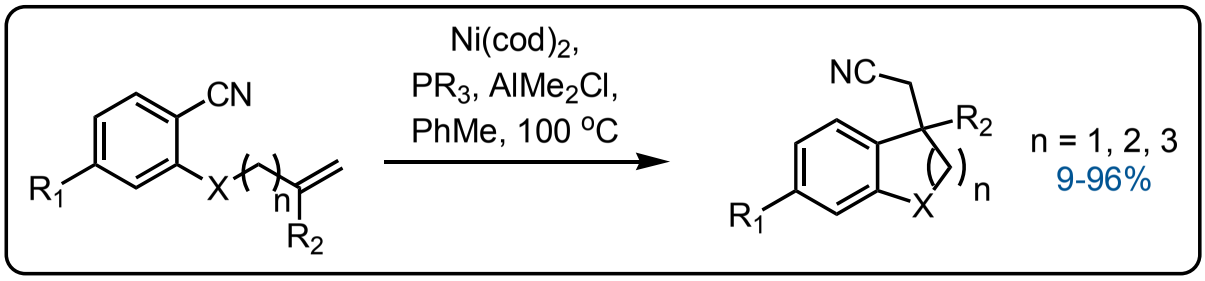
J. Am. Chem. Soc. **2006**, *128*, 7116



Y. Nakao, Y. Hirata, M. Tanaka, T. Hiyama
Angew. Chem. Int. Ed. **2008**, *47*, 387

The Title Paper (Nakao, Hiyama, Ohoshi) - Reaction Scope



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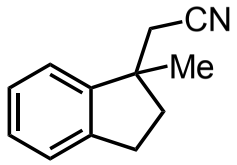
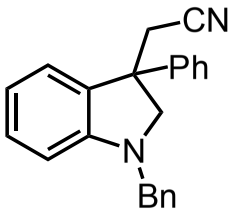
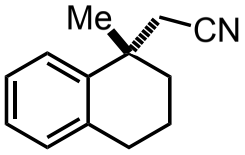
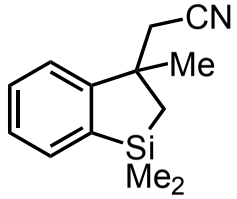
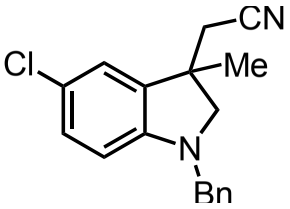
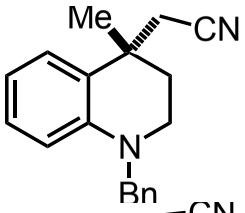
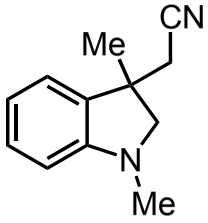
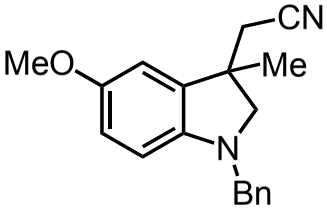
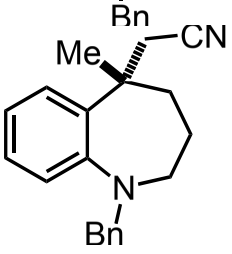
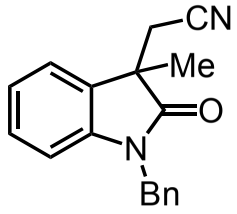
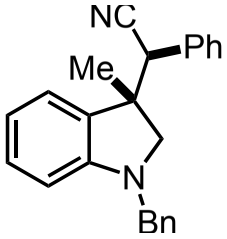
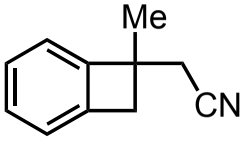
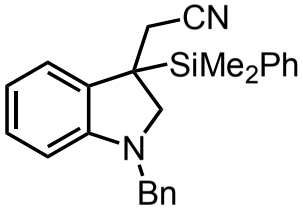
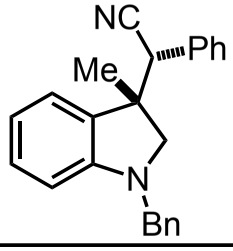
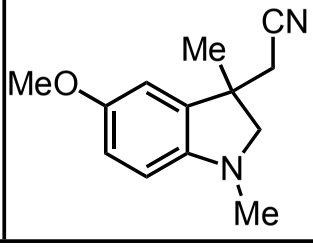
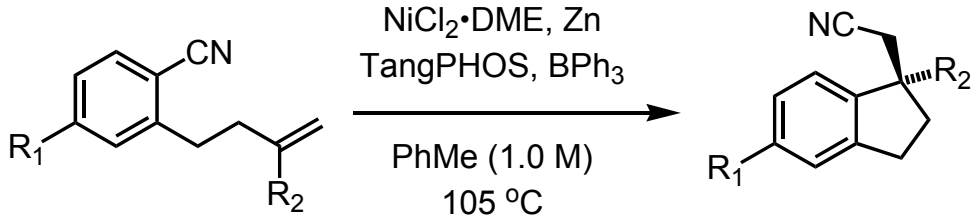
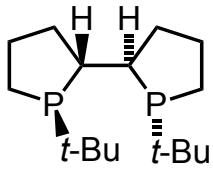
	93		89		91
	92		82		96
	86		85		58
	74		88		ND
	84		76		76

Title Paper (Jacobsen) - Reaction Scope





(*S,S,R,R*)-TangPHOS

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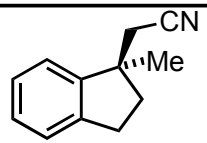
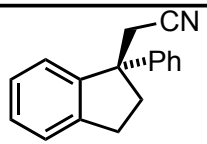
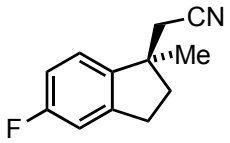
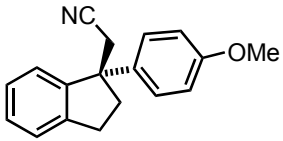
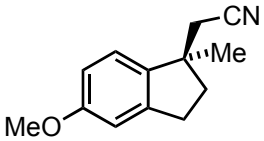
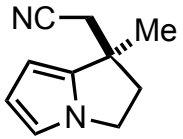
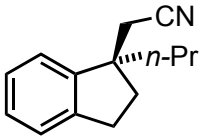
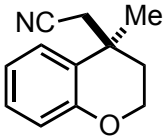
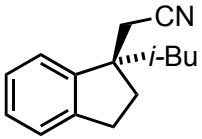
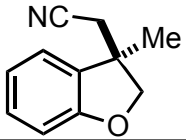
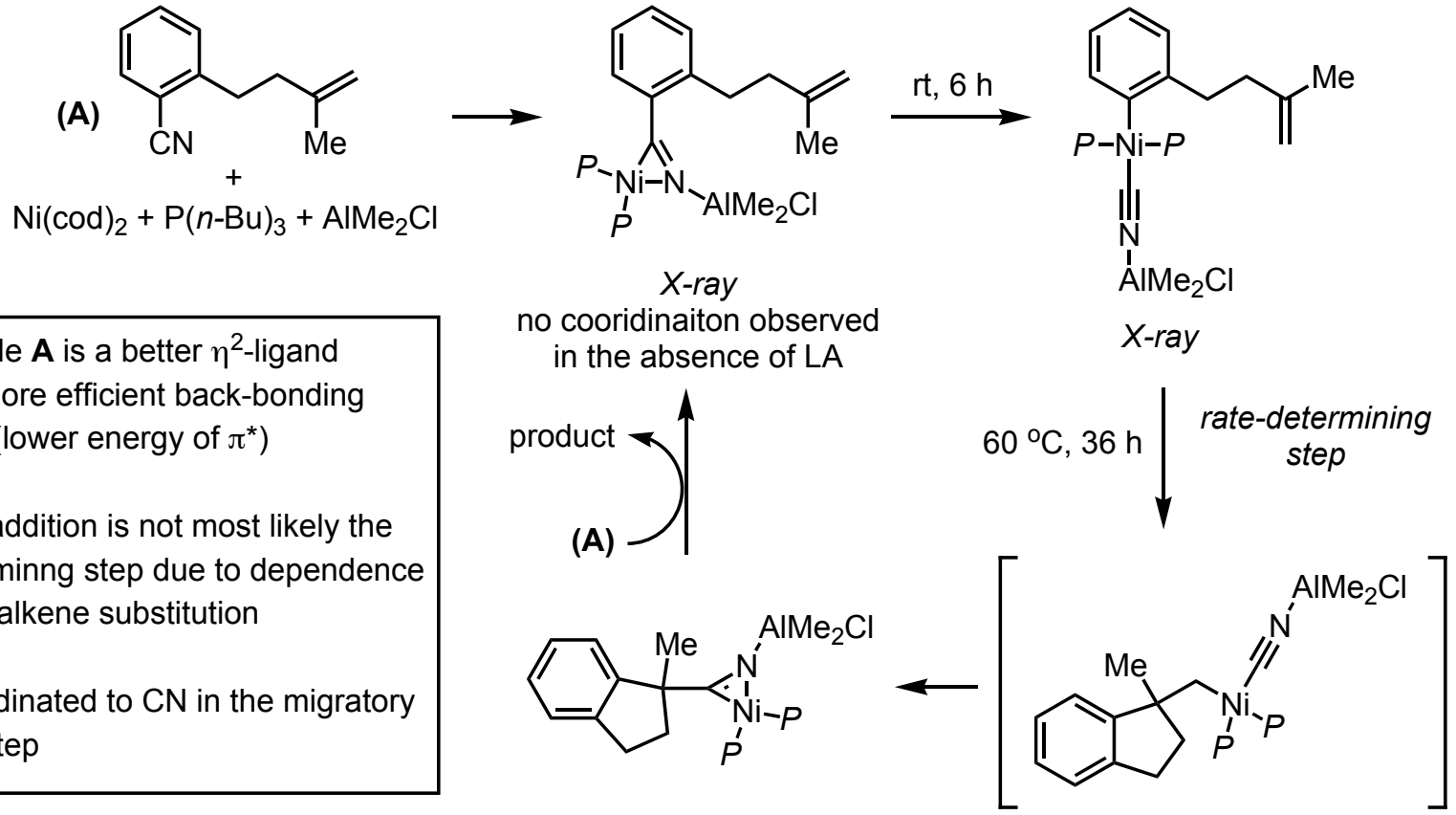
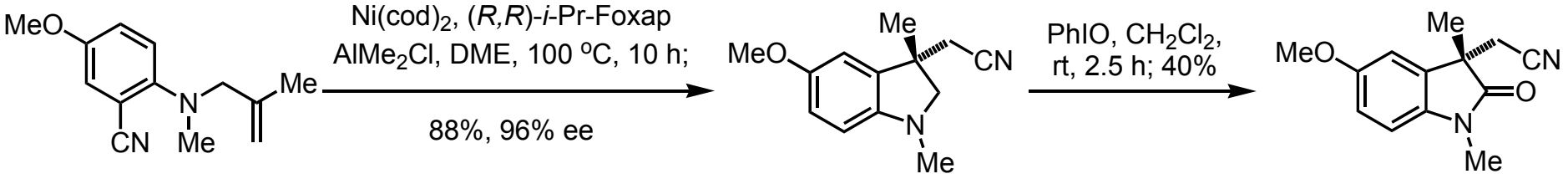
	85	93		72	95
	84	92		65	96
	75	93		77	97
	69	94		47	77
	75	95		0	nd

Mechanism of Arylcyanation

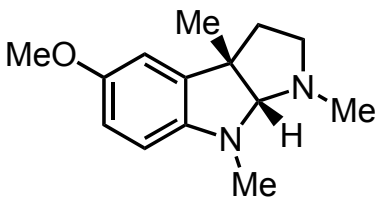


- aryl cyanide **A** is a better η^2-ligand due to a more efficient back-bonding from Ni(0) (lower energy of π^*)
- oxidative addition is not most likely the rate-determinng step due to dependence of ee's on alkene substitution
- LA is coordinated to CN in the migratory insertion step

Enantioselective Arylcyanation (Nakao, Hiyama, Ohoshi)

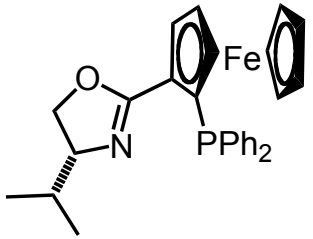


1. $LiAlH_4$, THF, rt, 1 h then reflux, 0.5 h; 64%
2. HCHO, $NaBH(OAc)_3$, MeOH, 0 °C to rt, 1.5 h; 92%

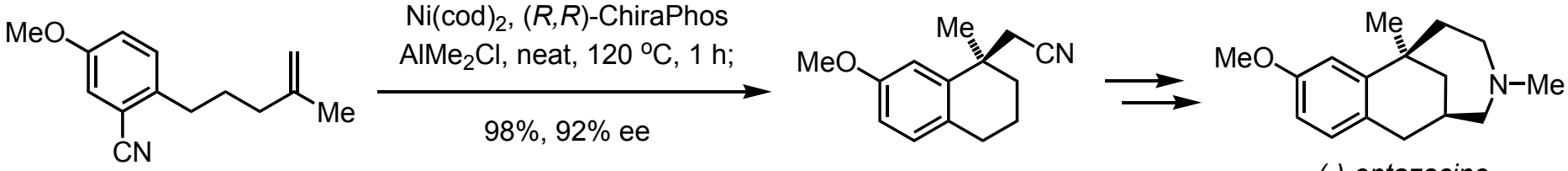


(-)-esermethole

intermediate to physostigmine and phenserine



(*R,R*)-*i*-Pr-Foxap



(-)-eptazocine

Summary

- Aryl and allyl cyanides are useful substrates in the carbocyanation reactions with alkynes and allenes catalyzed by Ni(0) complexes.
- Aryl cyanides undergo intramolecular carbocyclization with *gem*-di- and trisubstituted olefins in high yields and ee's.
- In order to achieve the practicality, the C-CN cleavage reactions need to be converted into intermolecular coupling with alkenes.