# The Career of Sukbok Chang

Sean Kennedy

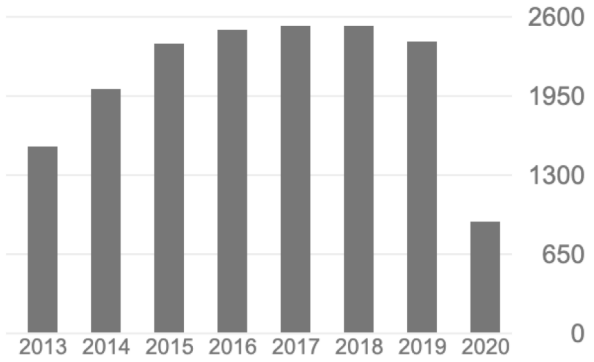
Levin Group Meeting

May 14, 2020

# Education & Career

| | |
|---|---|
| B.S. Chemistry, Korea University | 1985 |
| M.S. Chemistry, Korea Advanced Institute of Science and Technology (KAIST) | 1987 |
| Ph.D., Harvard University (Prof. Eric Jacobsen) | 1996 |
| Postdoctoral Fellow, California Institute of Technology (Prof. Robert Grubbs) | 1998 |

| | All | Since 2015 |
|---|---|---|
| Citations | 24999 | 13248 |
| h-index | 85 | 61 |
| i10-index | 193 | 168 |




**Professional Career**

| | |
|---|---|
| Assistant Professor, Ewha Women's University | 1998 |
| Professor, KAIST | 2002 |
| Distinguished Professor, KAIST | 2018- |

**Select Awards & Highlights**

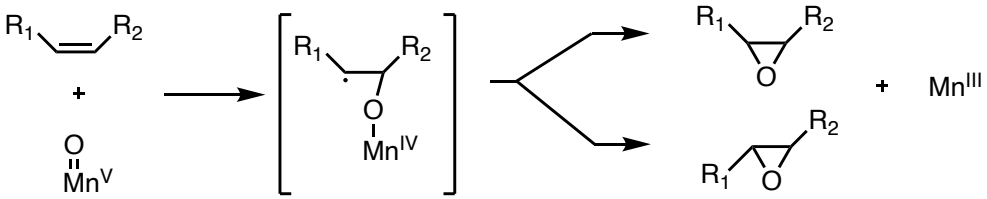
Humboldt Research Award (2017)

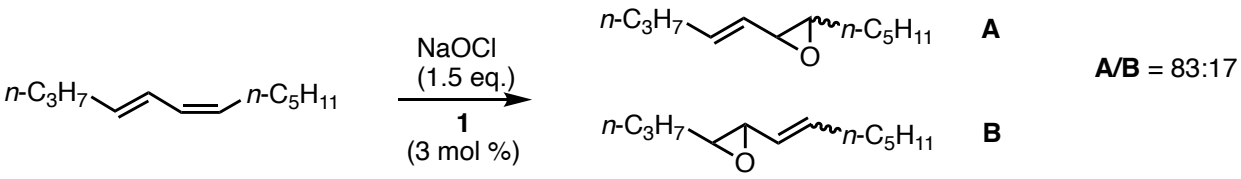
Associate Editor, ACS Catalysis (2015-)

**Korea Best Scientist & Engineer Award (2019)**

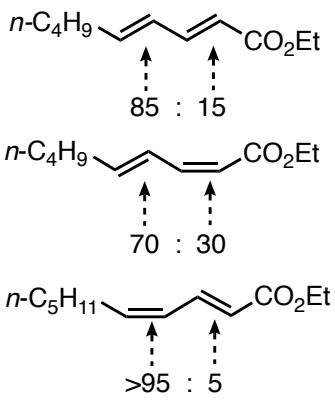
# Graduate Work

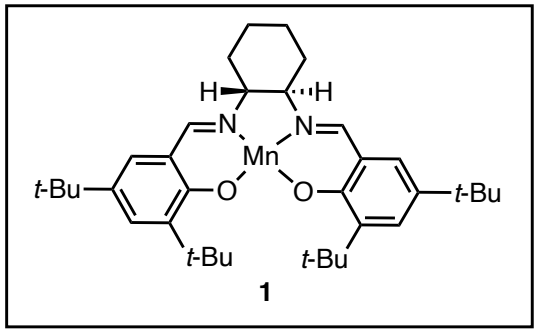
Jacobsen Epoxidation

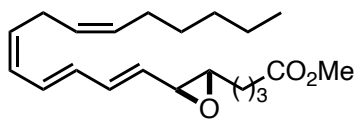



**A/B** = 83:17



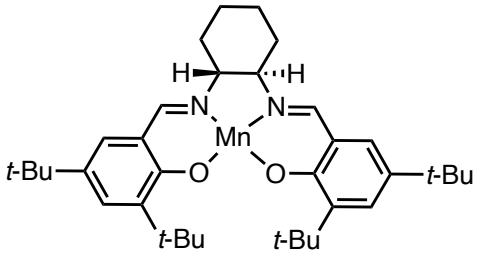



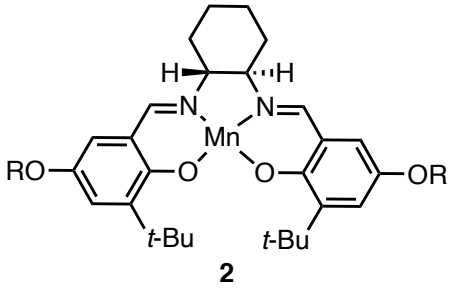

Leukotriene $A_4$, methyl ester

J. Org. Chem. **1993**, 6939

# Graduate Work

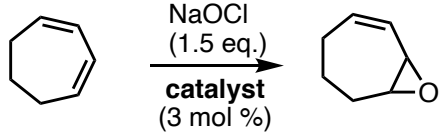


**1**

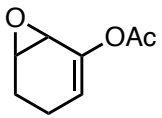


**2**

R = Si-*i*Pr$_3$



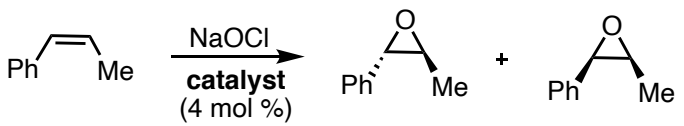

**1:** 40%, 63 ee
**2**: 45%, 64 ee



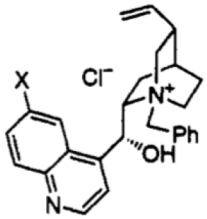
**1:** 30%, 85 ee
**2**: 32%, 90 ee

-wide range of ee and yield
-**2** was modestly more selective

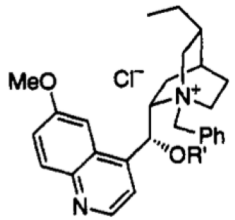
Tet. Lett. 1994**, 669**



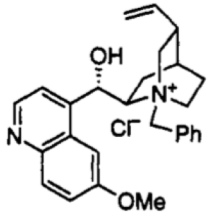

| | trans / cis |
|---|---|
| no additive | 39:61 |
| **3** | 92:8 |
| **4** | 94:6 |
| **5** | 84:16 |
| **6** | 86:14 |
| **7** | 93:7 |



**3**: X = OMe
**4**: X = H



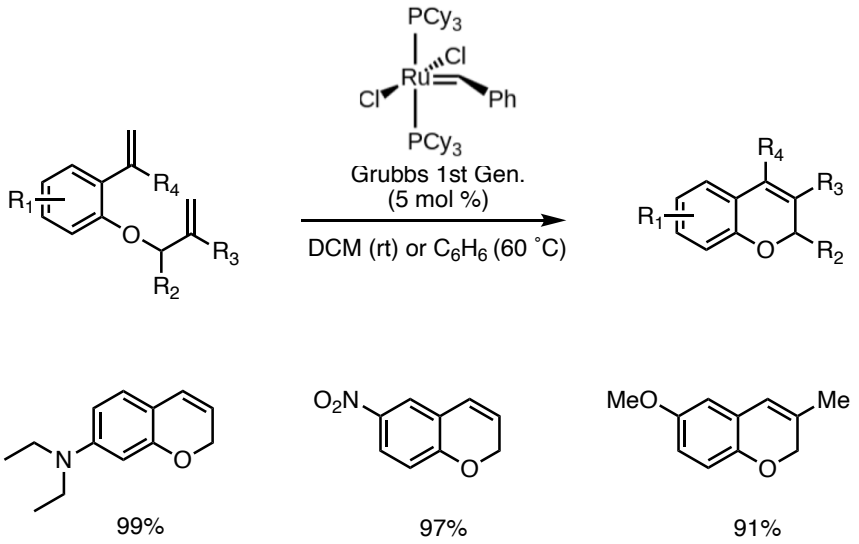
**5**: R' = Me
**6**: R' = 9-phenanthryl



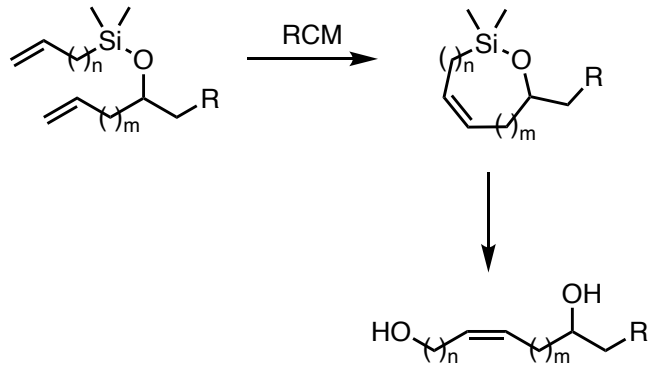
**7**

JACS **1994**, 6937

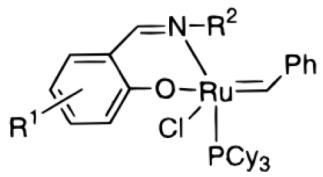
# Postdoctoral Research




J. Org. Chem. **1998,** 864

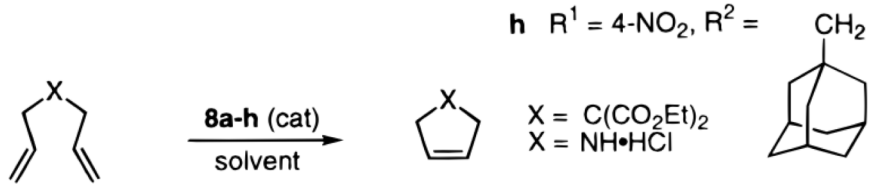



Organomettalics **1998**, 3460




**8a-h**

**a** $R^1$ = H, $R^2$ = 2,6-*i*-Pr$C_6H_3$
**b** $R^1$ = 4-$NO_2$, $R^2$ = 2,6-*i*-Pr$C_6H_3$
**c** $R^1$ = 4-$NO_2$, $R^2$ = 2,6-Me-4-MeO$C_6H_2$
**d** $R^1$ = 4-$NO_2$, $R^2$ = 2,6-Me-4-Br$C_6H_2$
**e** $R^1$ = 4-$NO_2$, $R^2$ = 2,6-Cl-4-$CF_3C_6H_2$
**f** $R^1$ = 6-Me-4-$NO_2$, $R^2$ = 2,6-*i*-Pr$C_6H_3$
**g** $R^1$ = 4-$NO_2$, $R^2$ = 2,6-*i*-Pr-4-$NO_2$-$C_6H_3$
**h** $R^1$ = 4-$NO_2$, $R^2$ =




Tet. Lett. **1997**, 4757

# Independent Career

C-H Functionalization

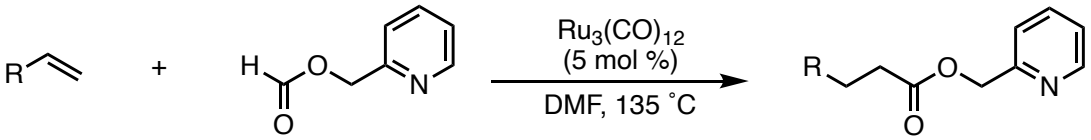
Multicomponent Reactions

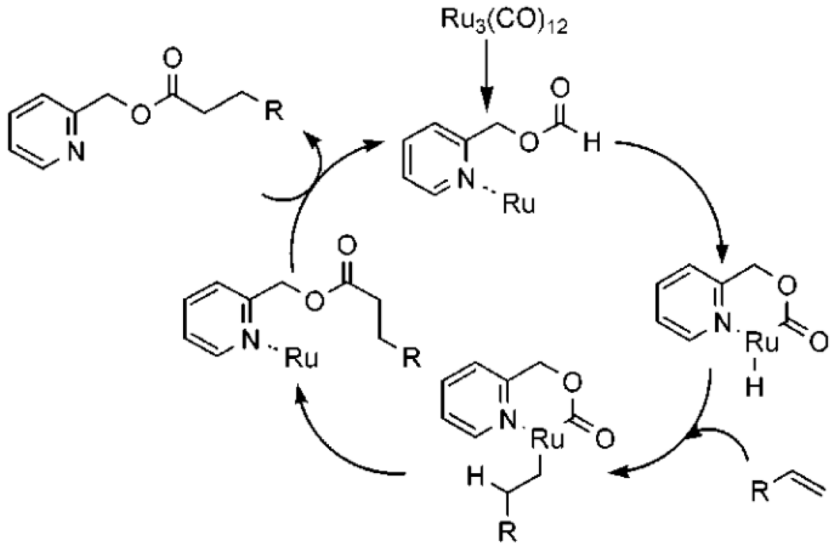
C-N Bond Formation from Azide Sources

Group 9 Metal Catalysts
(Co, Rh, Ir)

Heteroarene Reduction

# Hydroesterification

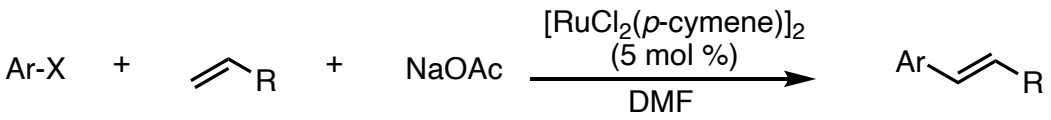


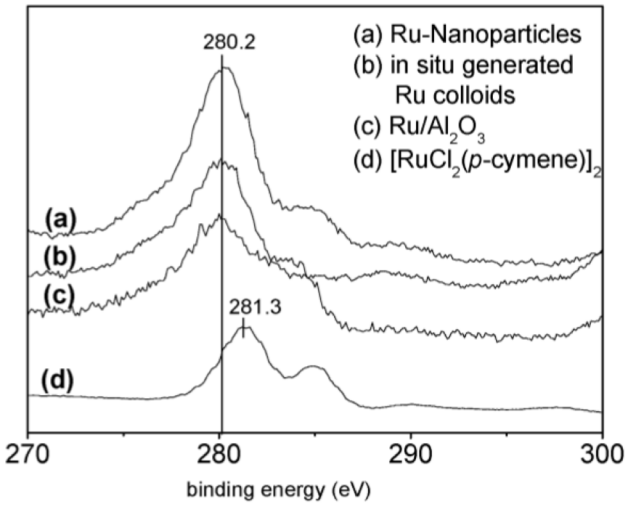



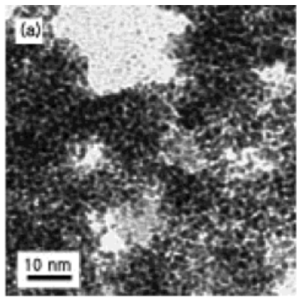

Chelation blocks decarbonylation

JACS **2002**, 750

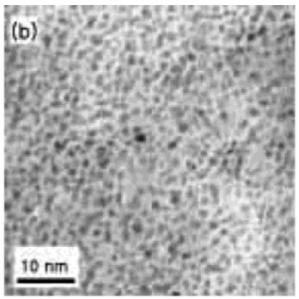
# Ru Colloids



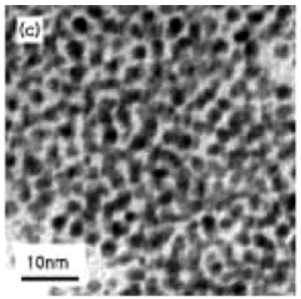



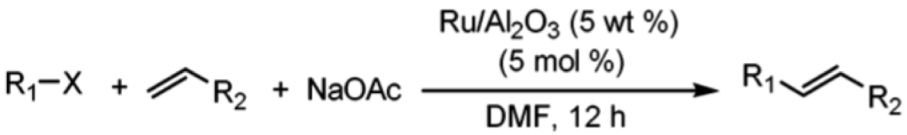

$[RuCl_2(p\text{-cymene})]_2$ with NaOAc




$[RuCl_2(p\text{-cymene})]_2$ with NaOAc, iodobenzene ethyl acrylate

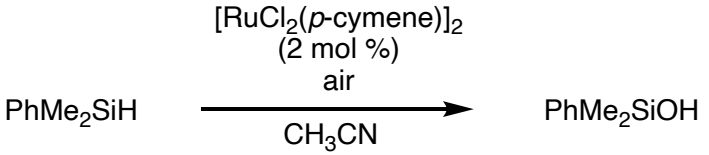


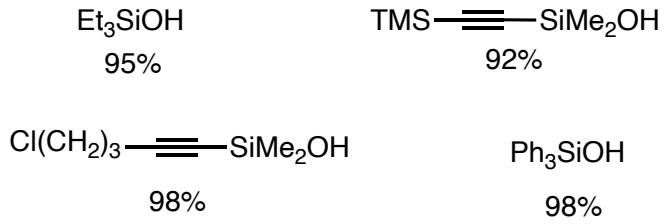

Independently prepared nanoparticles



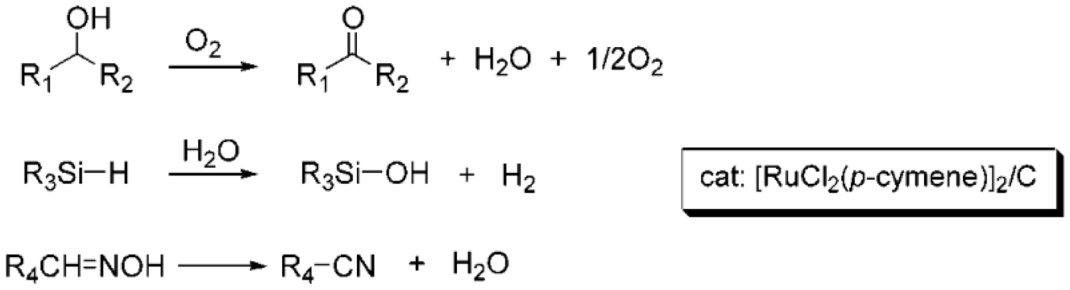

JACS **2004**, 250

# Organosilane Oxidation



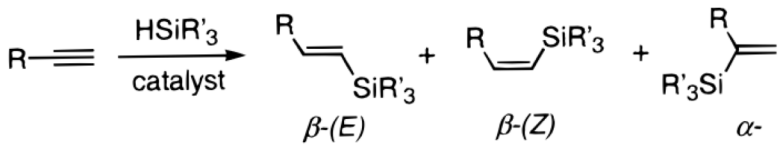



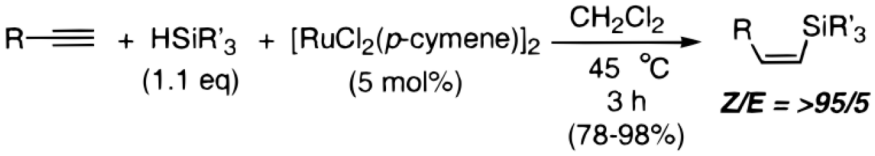

JACS **2000**, 12011

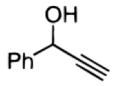
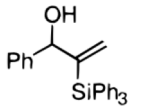
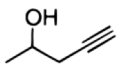
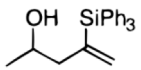
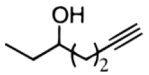
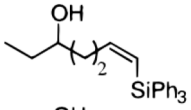
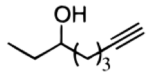
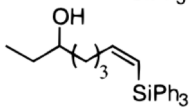



Org. Lett. **2002**, 2369

# Hydrosilylation

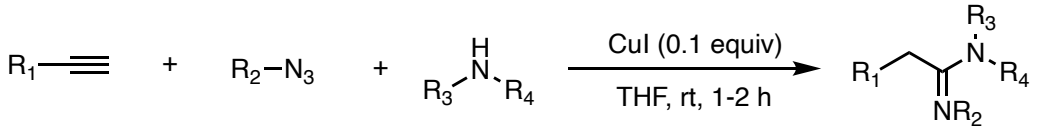


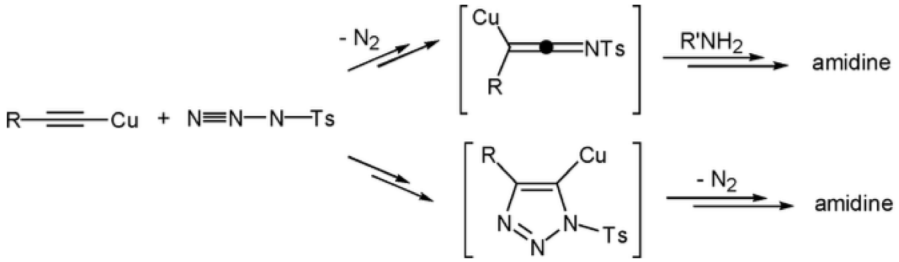




| alkyne | β-(Z):α- | major product | yield (%) |
|---|---|---|---|
|  | 13:87 |  | 60 |
|  | 2:98 |  | 59 |
|  | 92:8 |  | 53 |
|  | 96:4 |  | 61 |

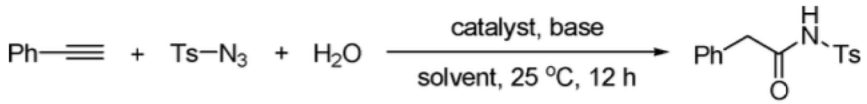
Org. Lett. **2000**, 1887

# Multicomponent Reactions



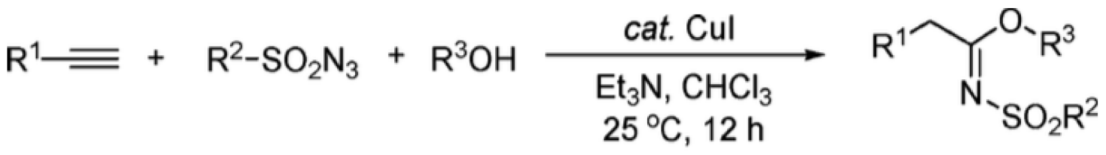

JACS, **2005**, 2039



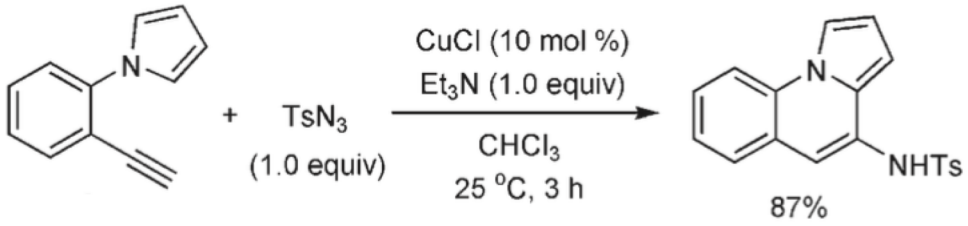

| entry | catalyst | base | solvent | yield (%) |
|---|---|---|---|---|
| 1 | CuI | | $CHCl_3$ | <1 |
| 2 | CuI | $Et_3N$ | $CHCl_3$ | 95 |
| 3 | CuI | $Et_3N$ (0.2 equiv) | $CHCl_3$ | 27 |
| 4 | CuI | $(i\text{-}Pr)_2NEt$ | $CHCl_3$ | 47 |
| 5 | CuI | pyridine | $CHCl_3$ | 35 |
| 6 | CuI | $K_2CO_3$ | $CHCl_3$ | <1 |
| 7 | CuI | $Et_3N$ | THF | 30 |
| 8 | $CuBr{\cdot}SMe_2$ | $Et_3N$ | $CHCl_3$ | 67 |

JACS, **2005**, 16046

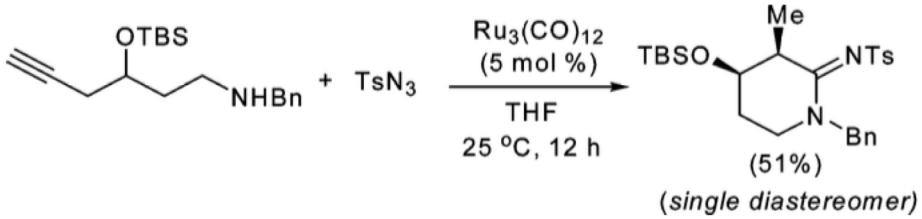
# Multicomponent Reactions




Org. Lett. **2006**, 1347

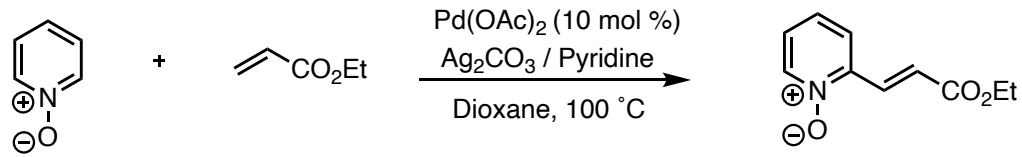


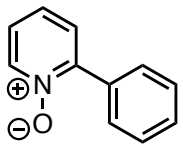

Angew. Chem. **2008**, 2836



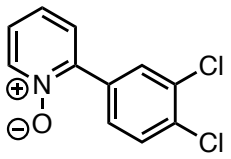

JACS **2006**, 12366

# N-Oxides

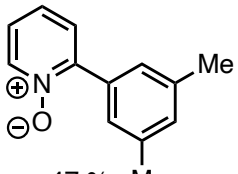


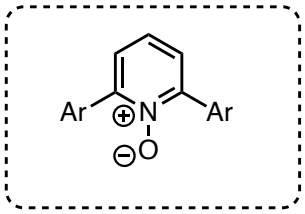
79 %
3:1

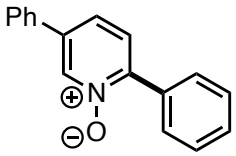



68 %
3:1



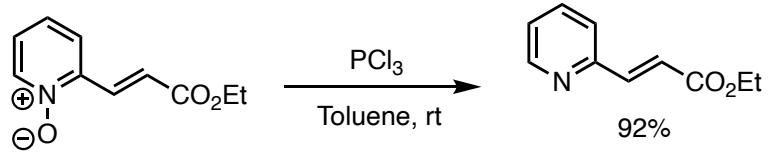

47 % Me
15:1




65%
20:1 mono/di

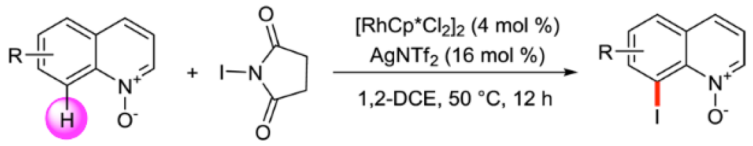
40 equiv arene

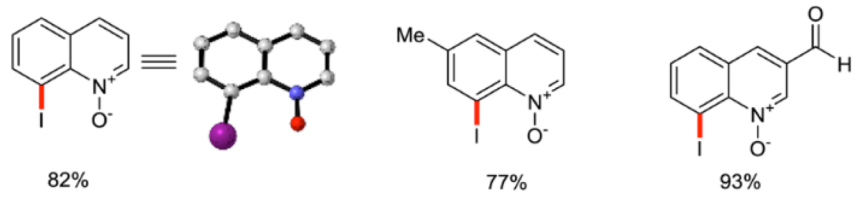


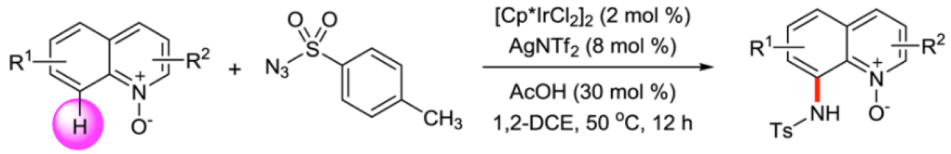

92%

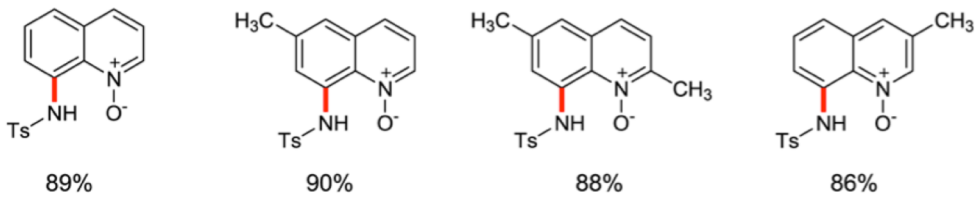
JACS, **2008**, 9254

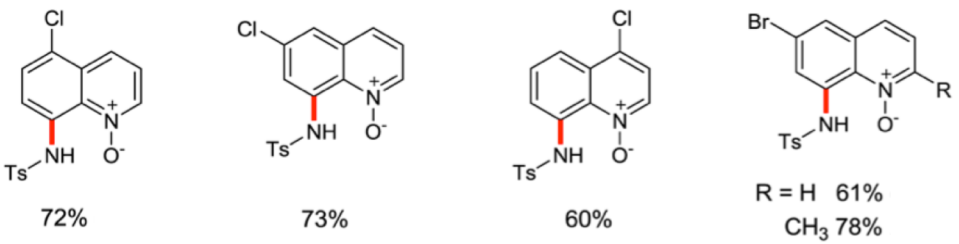
# N-Oxides

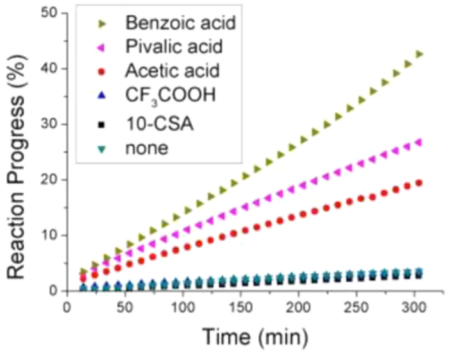


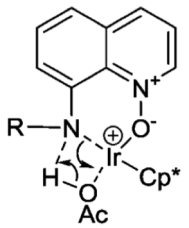



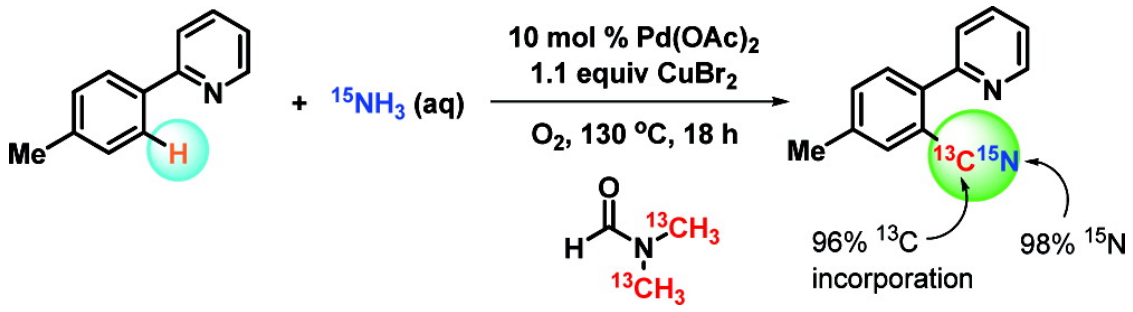



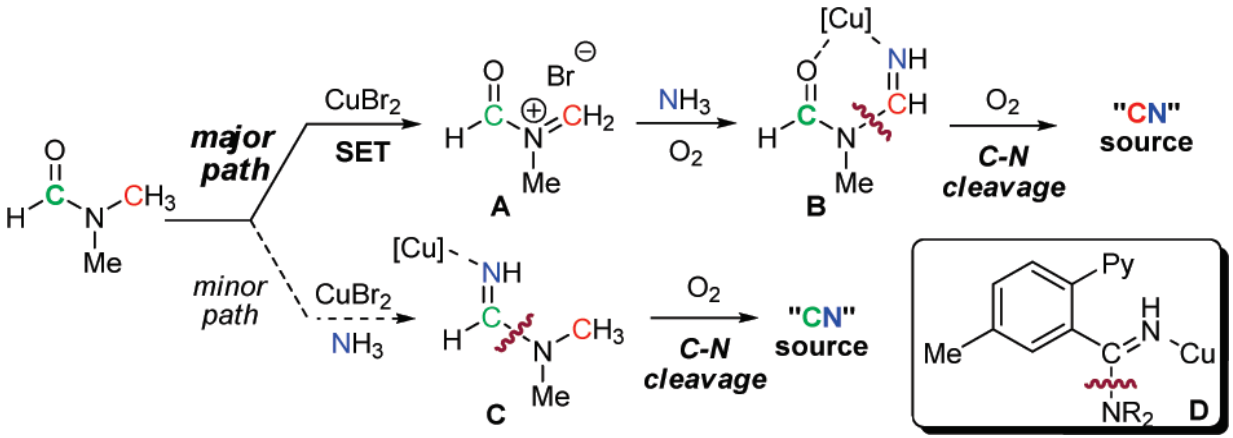



JACS **2014**, 10770

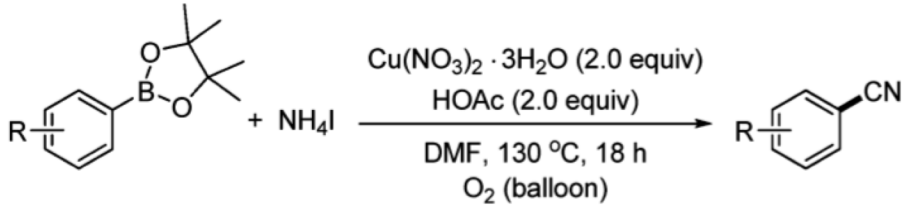
# Arene Cyanation

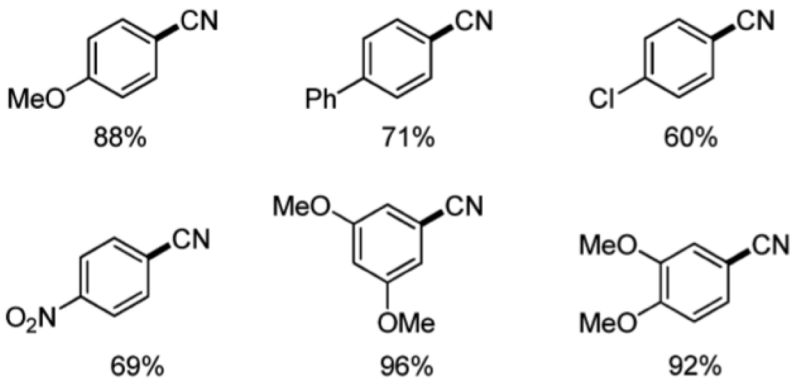


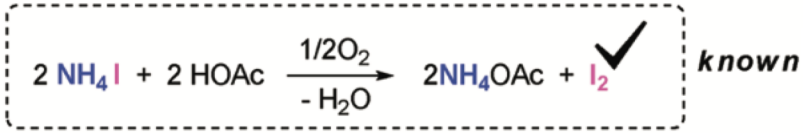



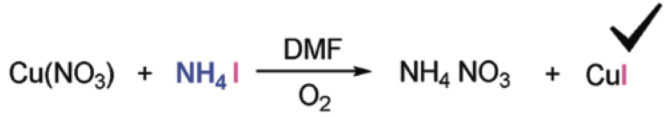

JACS **2010**, 10272

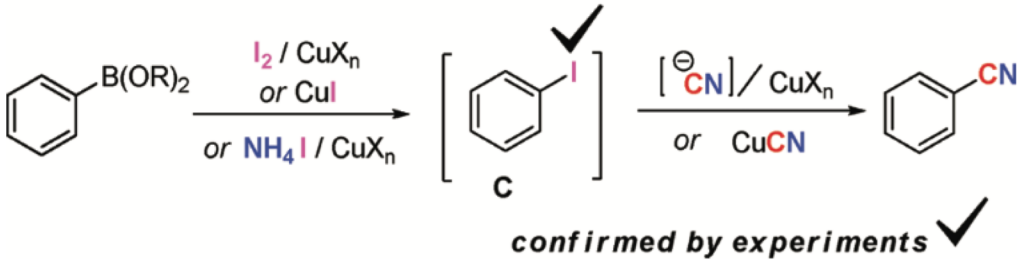
# Arene Cyanation



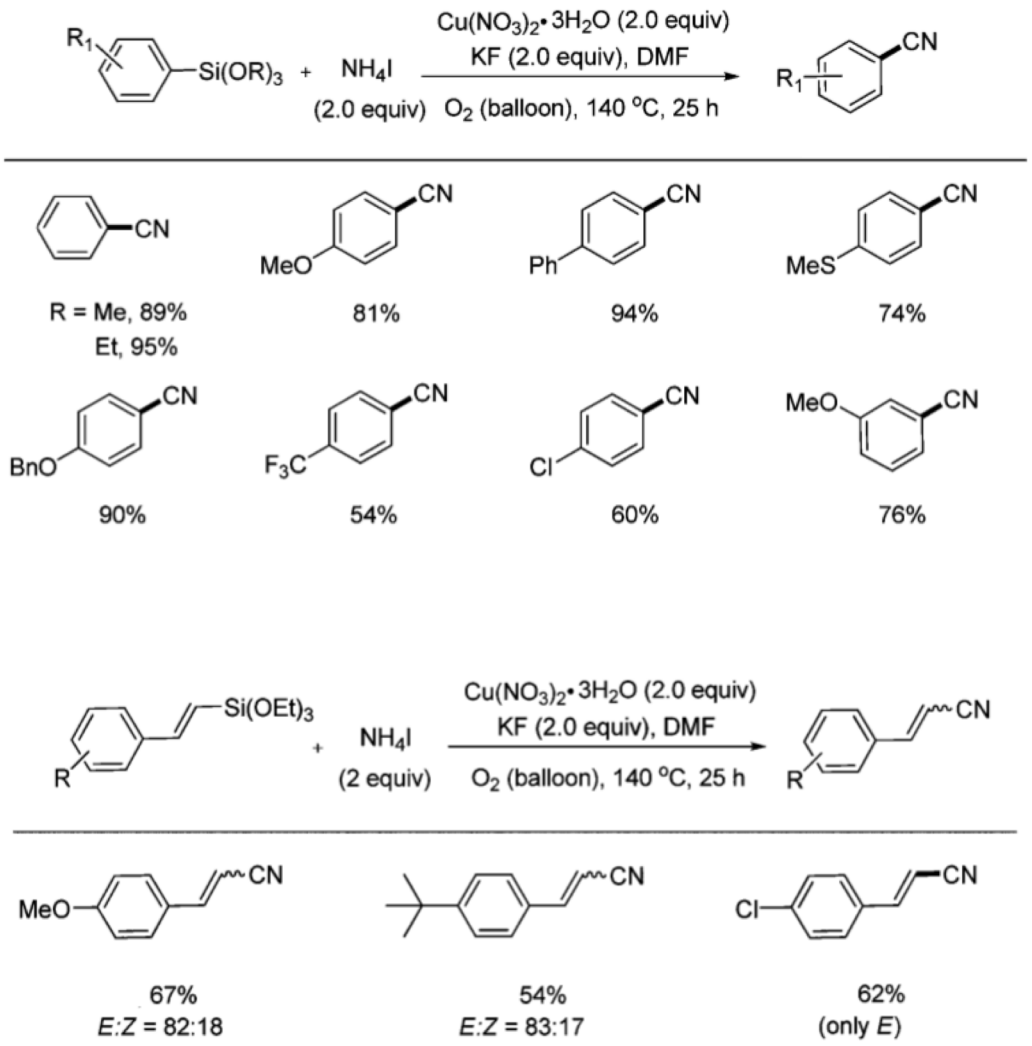



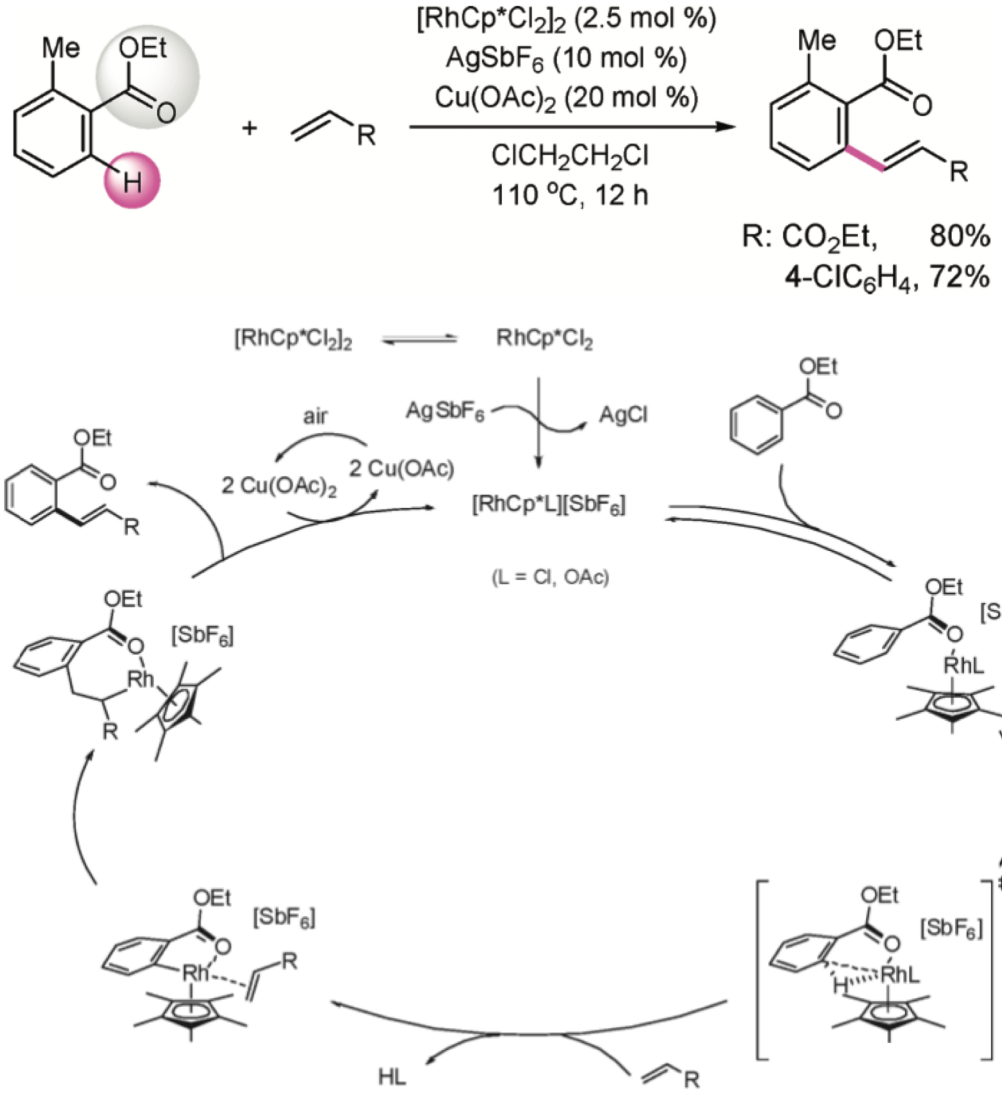

JACS, **2012**, 2528

# Arene Cyanation



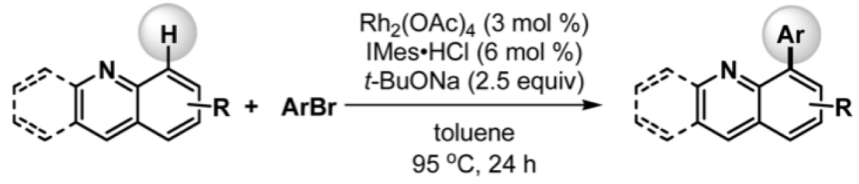

Org. Lett. **2013**, 1990

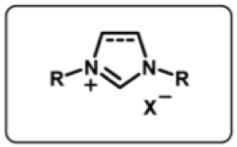
# Arene C-H Functionization



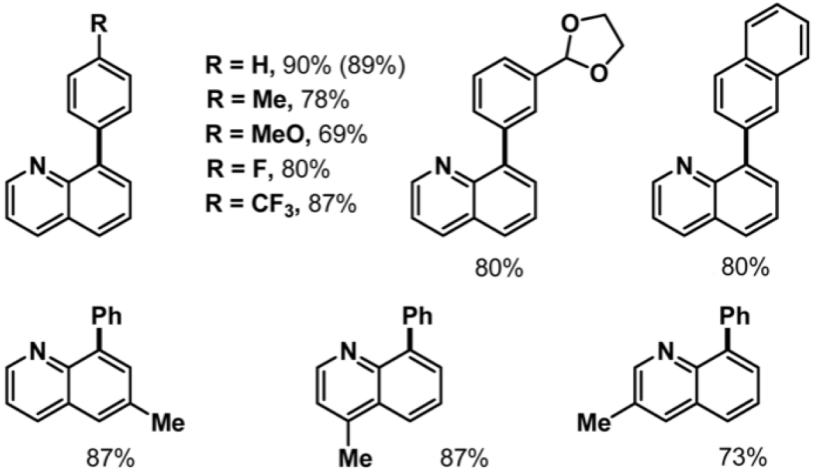

Org. Lett. **2011**, 2372

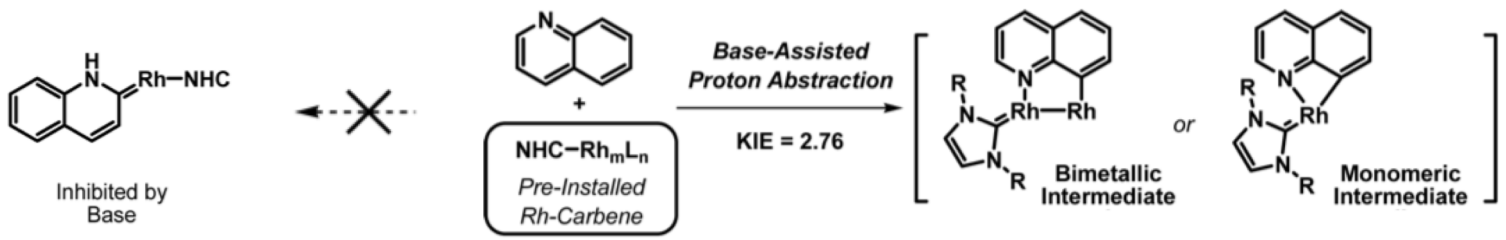
# Quinoline C-H Functionization



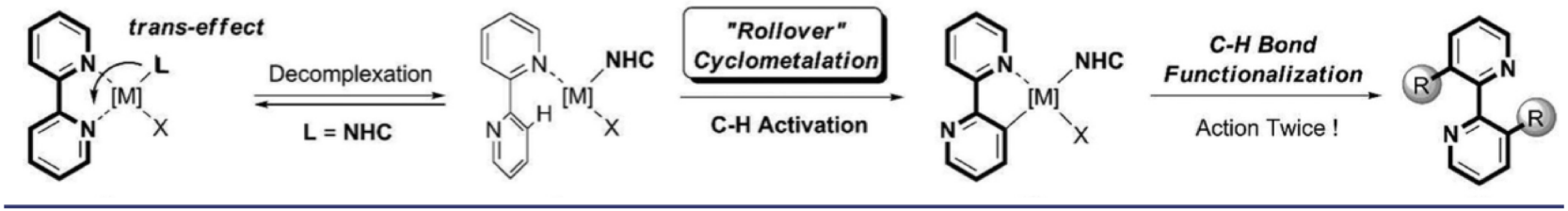

IMes: R = 2,4,6-trimethylphenyl

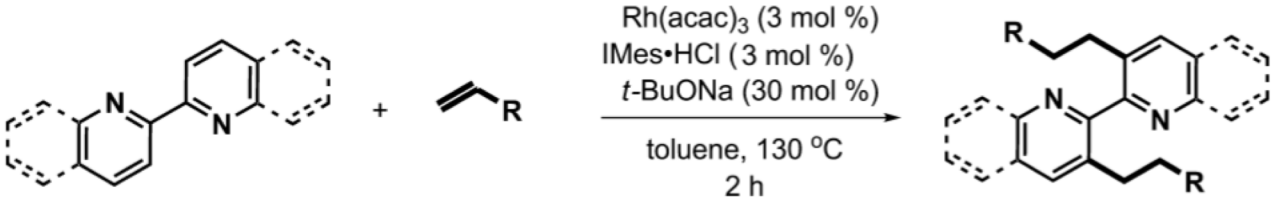


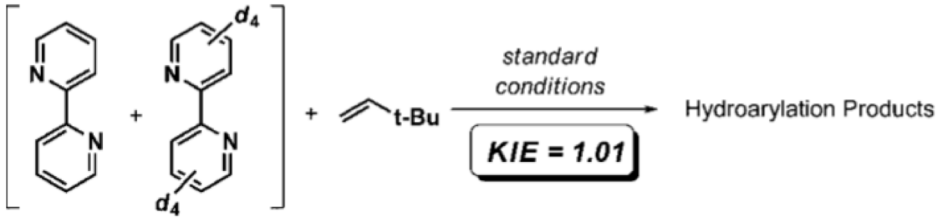



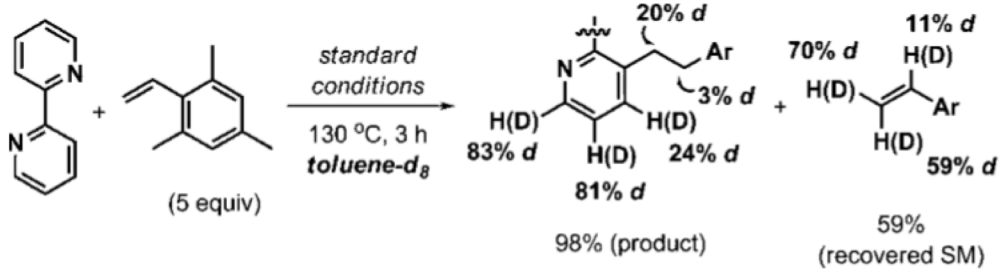

JACS **2011**, 3780

# Rollover Metalation



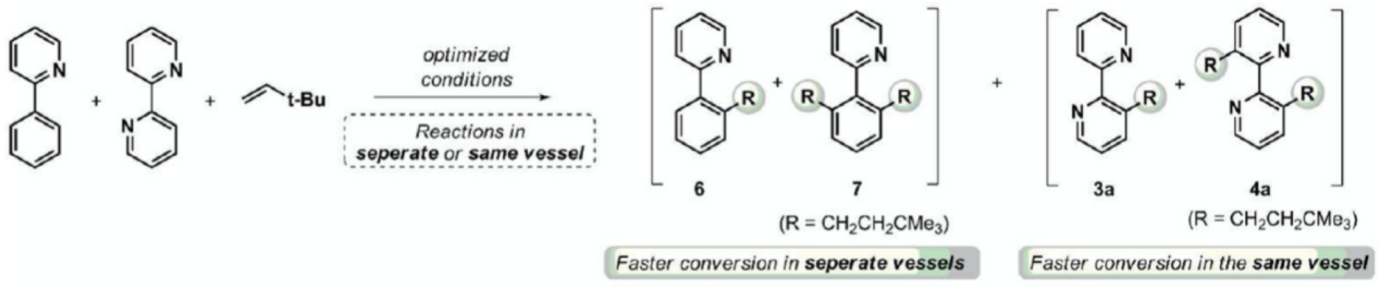



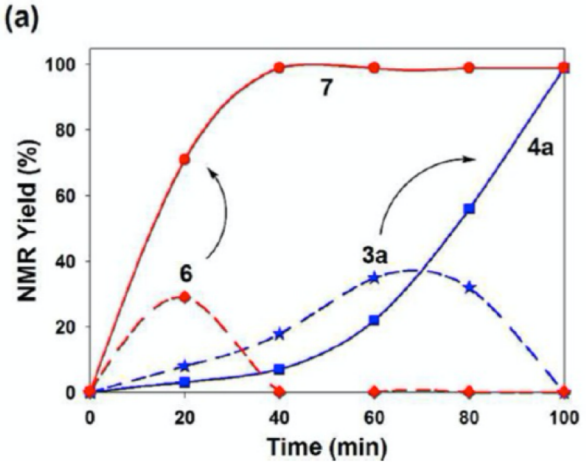



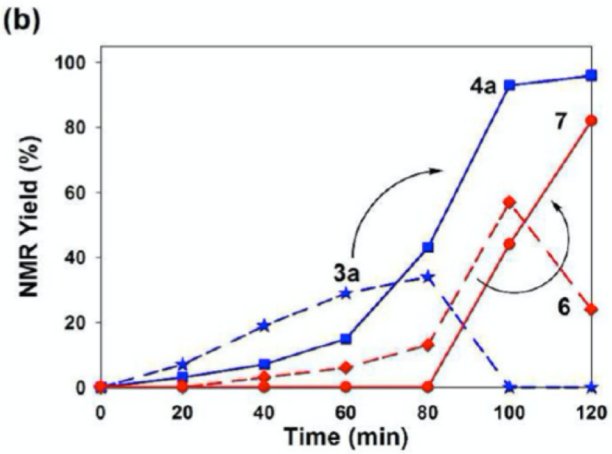



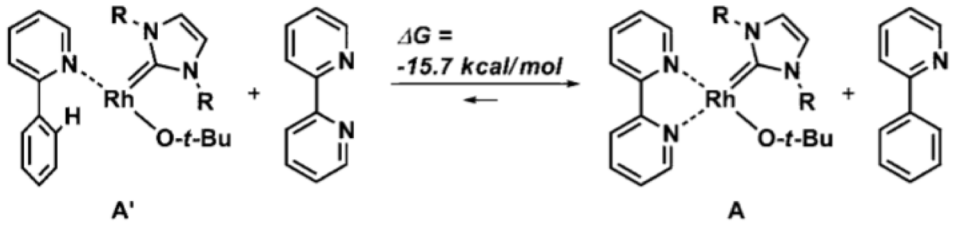

JACS **2012,** 17778

# Rollover Metalation



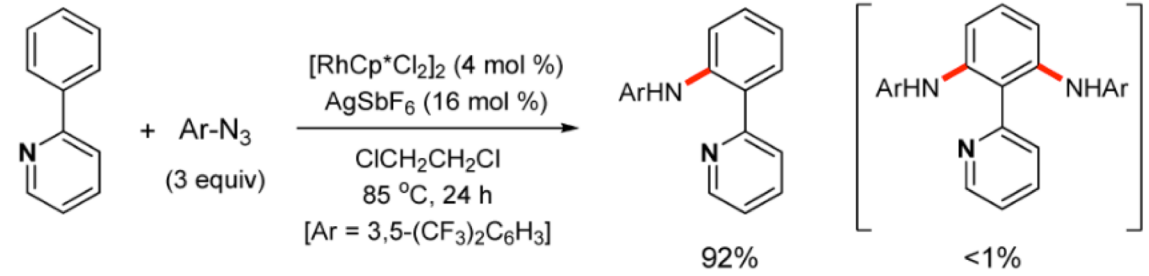



# H-Bond Purine Directing

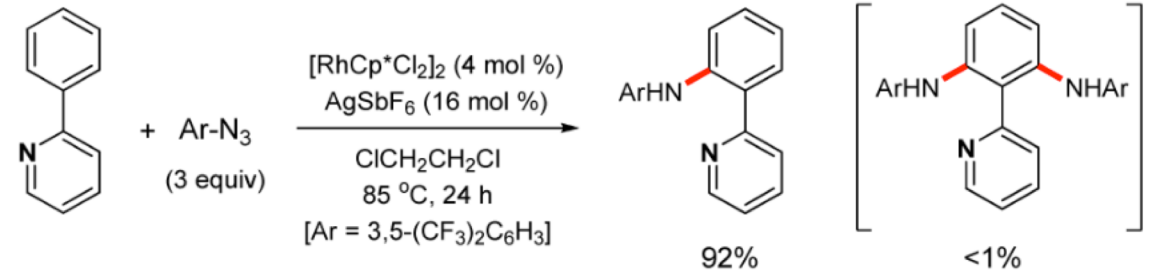
**Pyridine** as a directing group



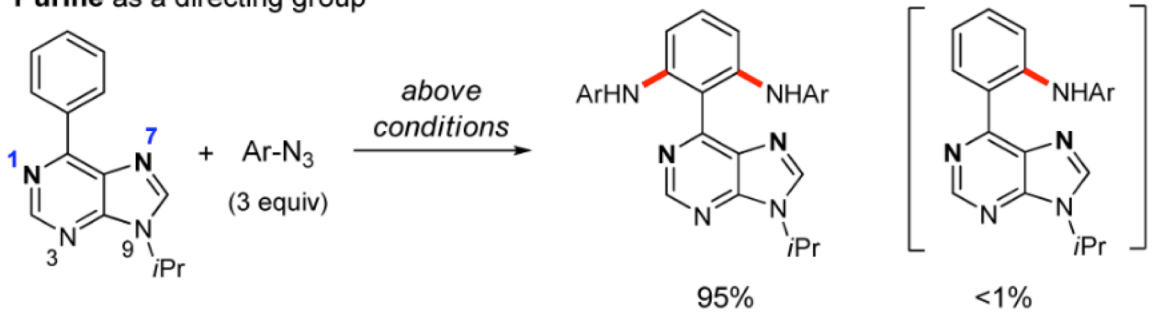

JACS, **2014**, 1132

# H-Bond Purine Directing

**Pyridine** as a directing group

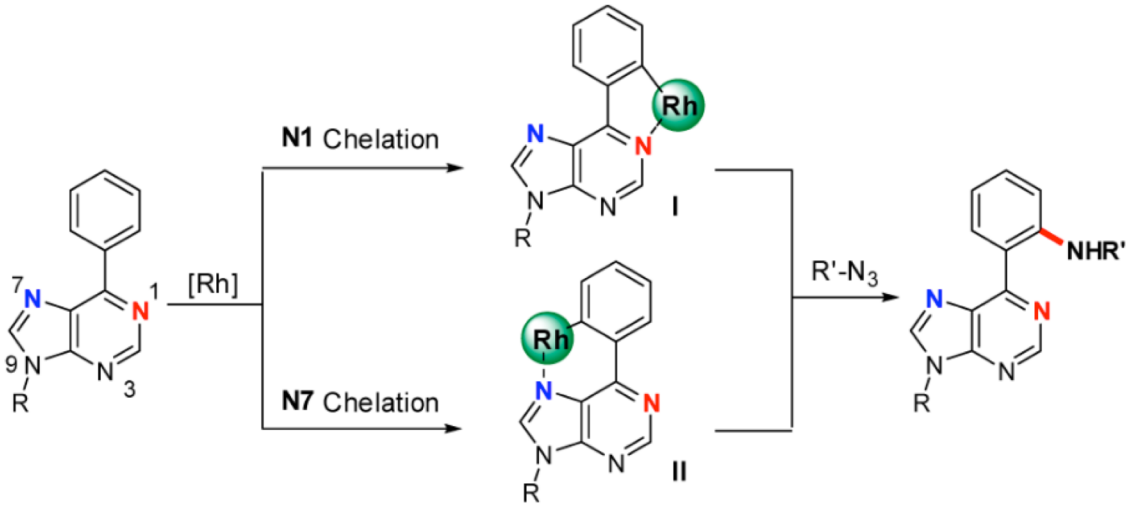


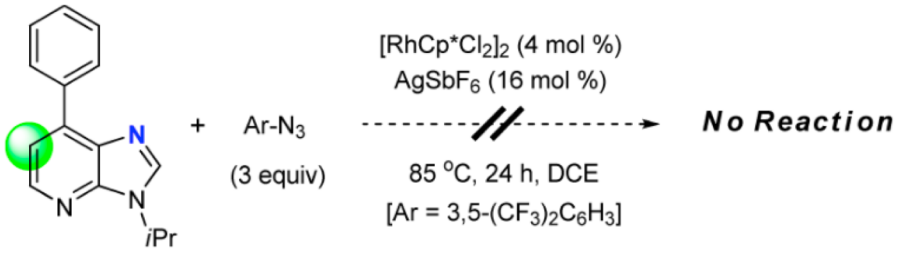

**Purine** as a directing group

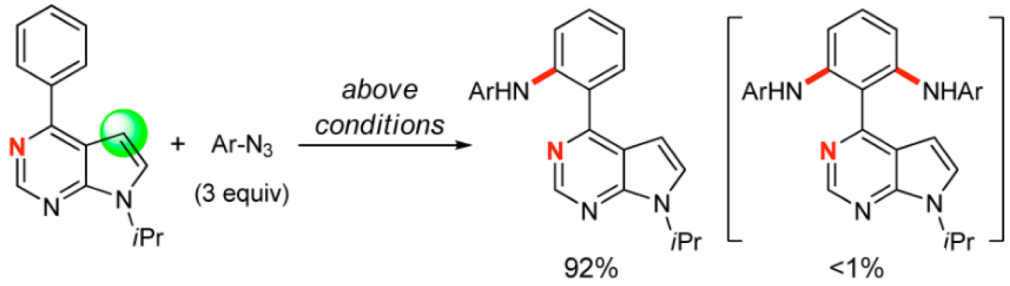



JACS, **2014**, 1132

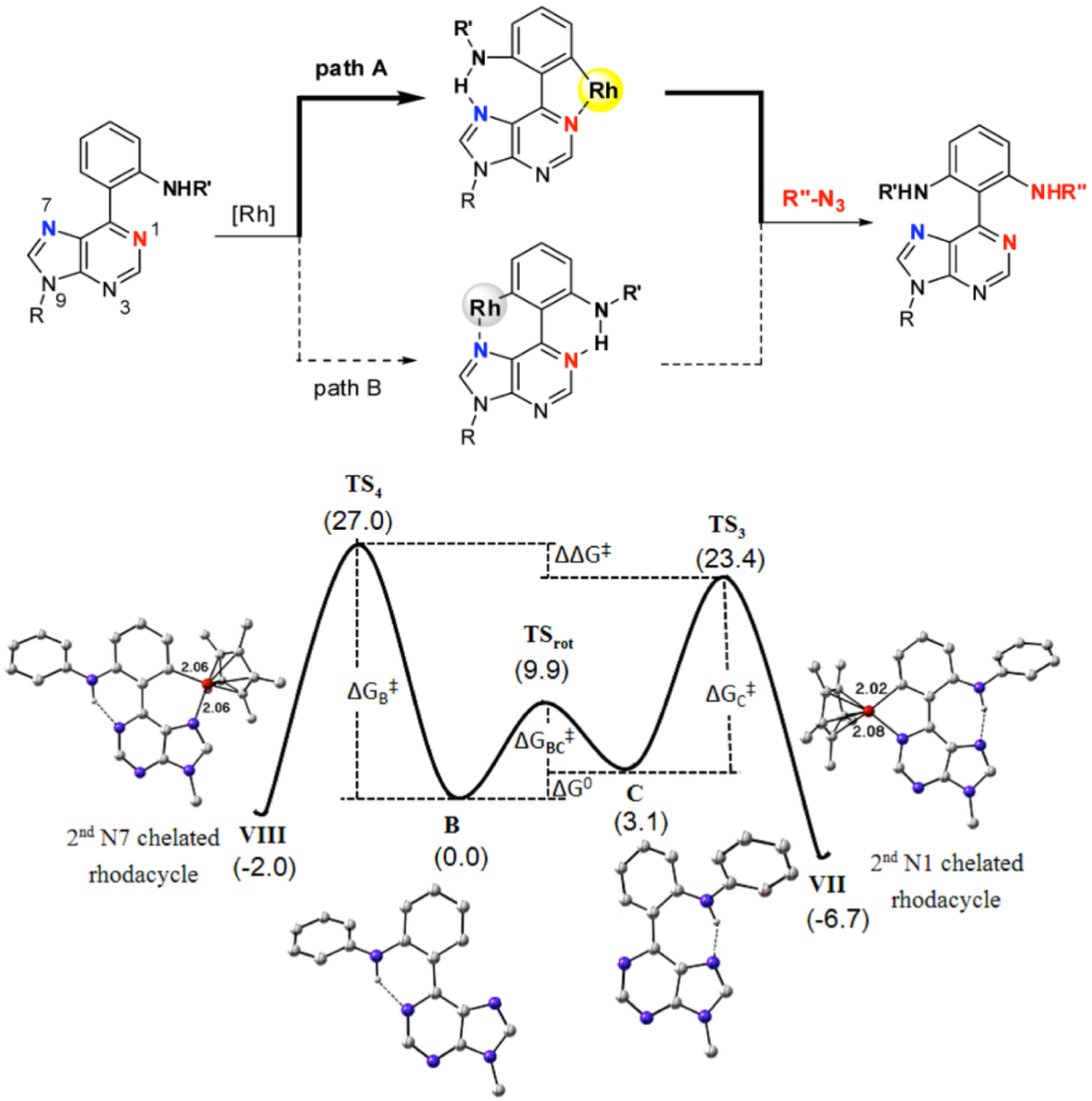
# H-Bond Purine Directing



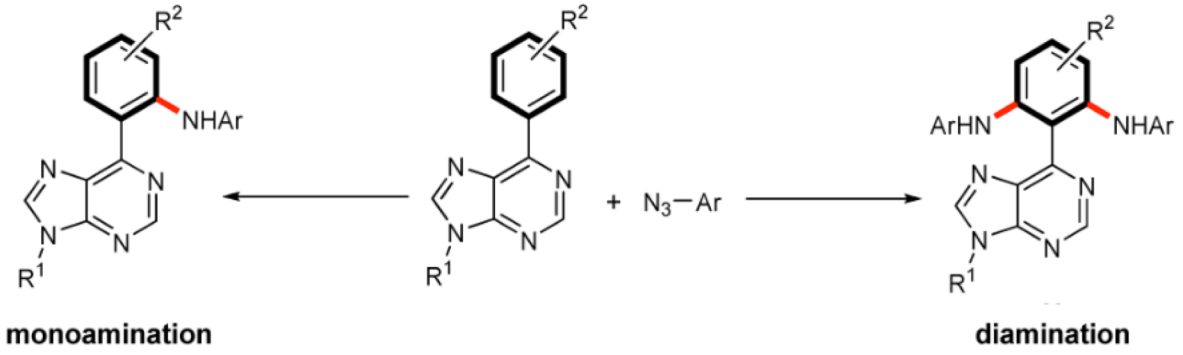



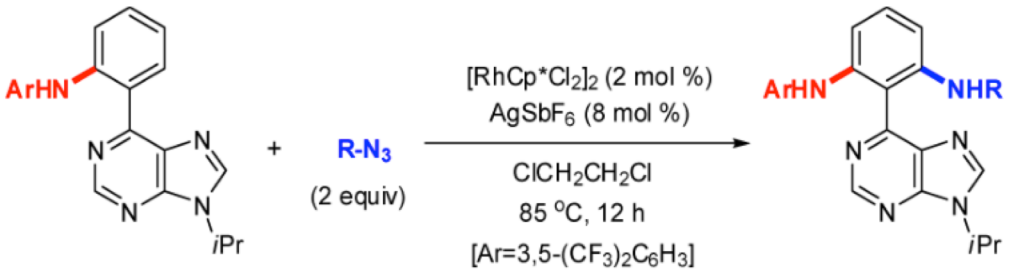



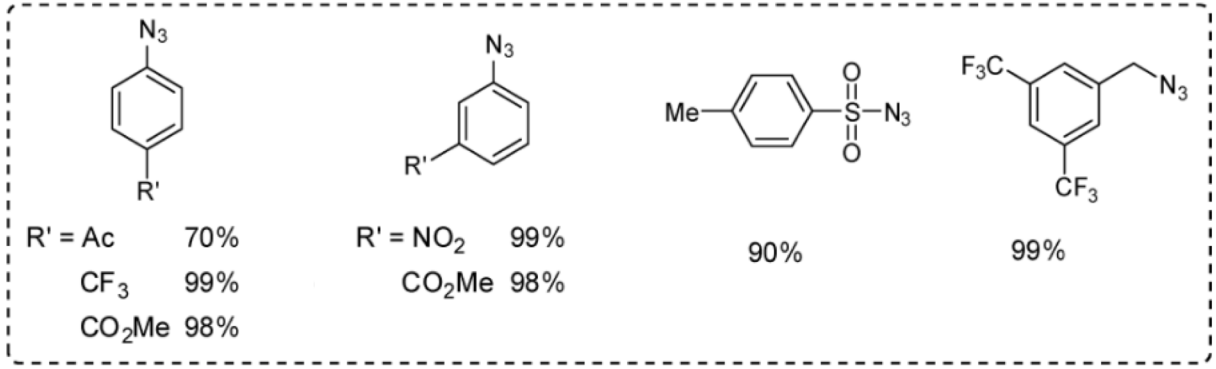
# Second Amination



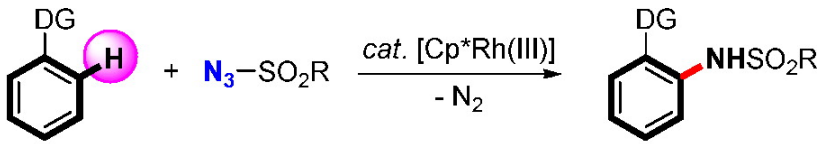
# Second Amination



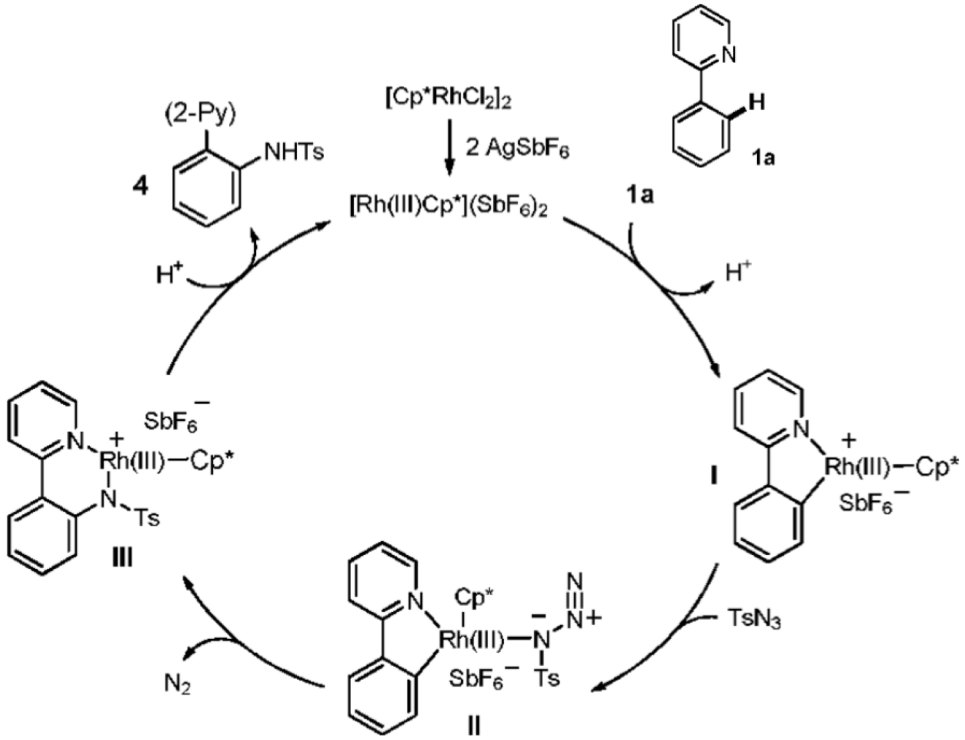



# C-H Amidation with Azides

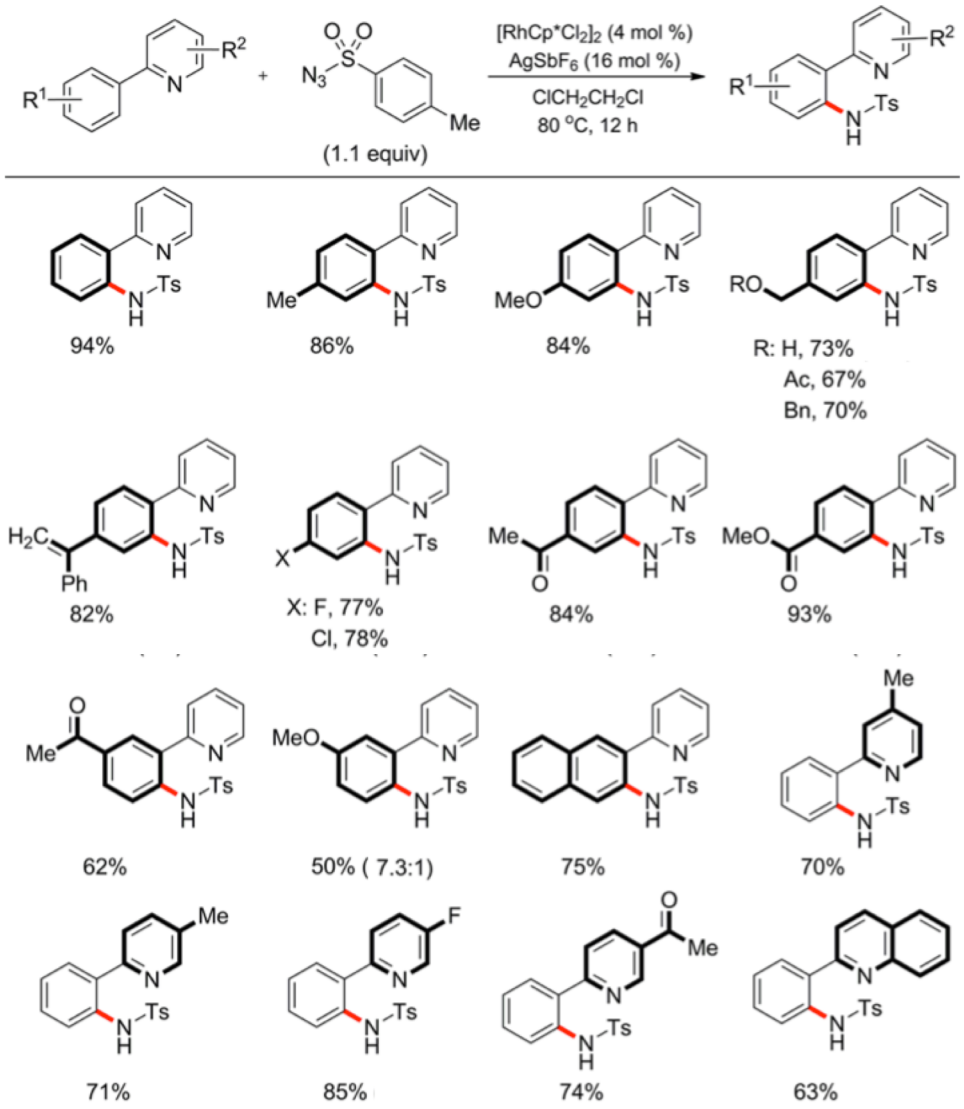



(DG = Directing Groups)

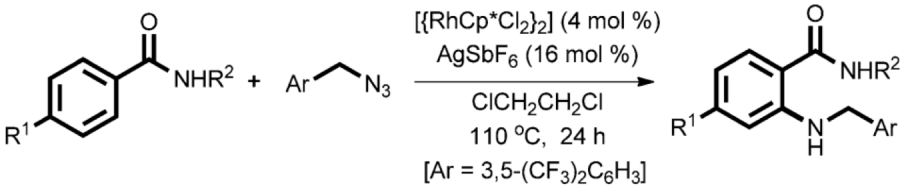


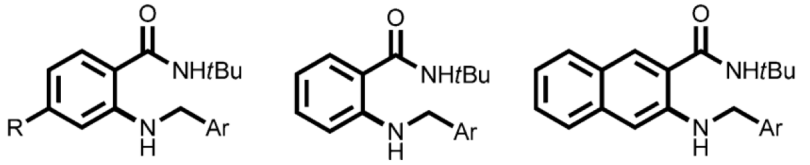

JACS **2012**, 9110

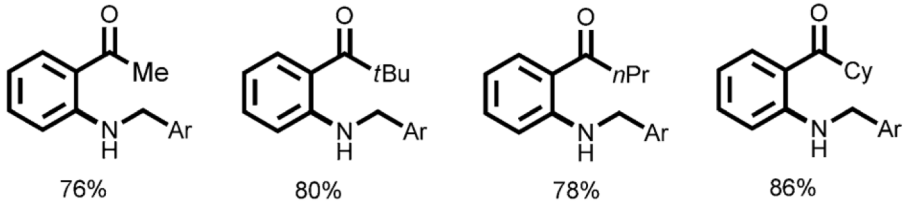
# C-H Amidation with Azides



# C-H Amination with Azides

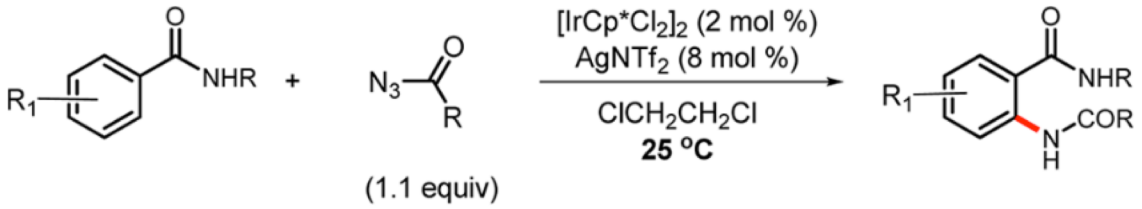


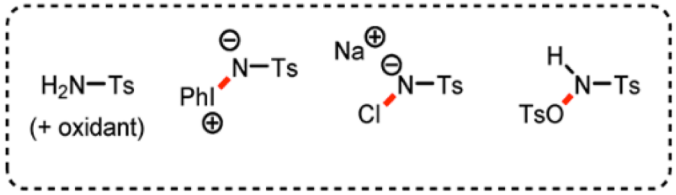



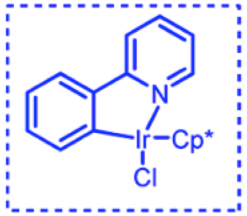




Angew. Chem. **2013**, 8031

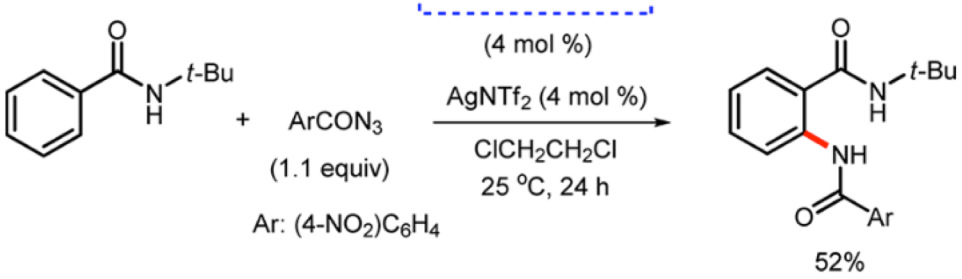
# Iridium C-H Activation



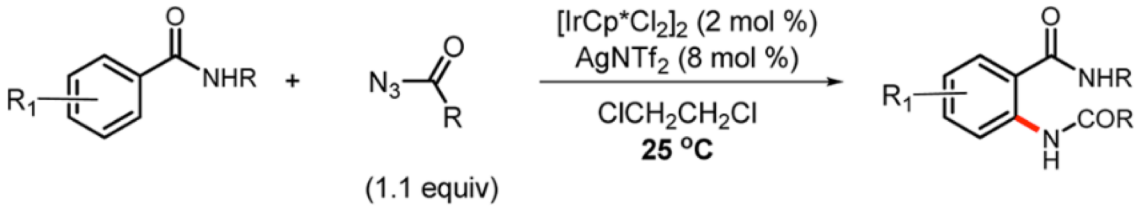

(4 mol %)

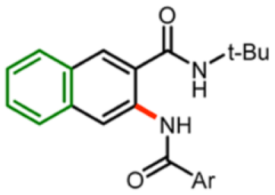



52%

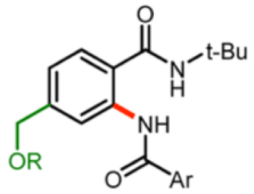
JACS **2013**, 12861

# Iridium C-H Activation

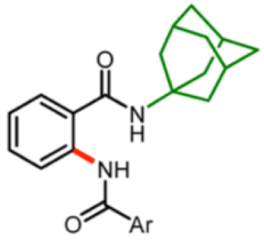


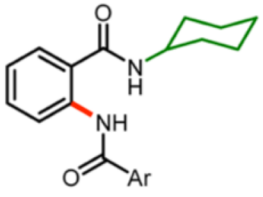

99%



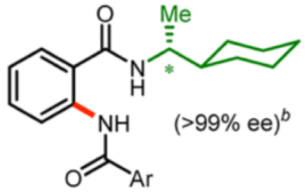

R = H 77%
= OAc 89%



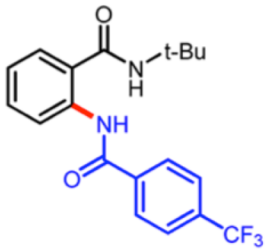

93%



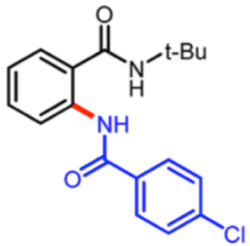

93%



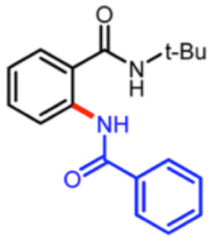

98%




84%




80%

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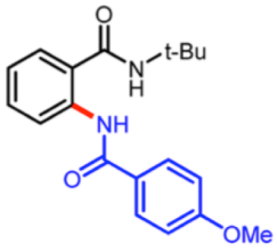
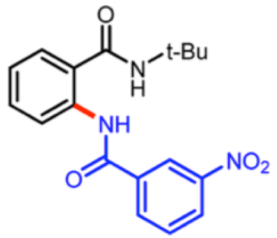
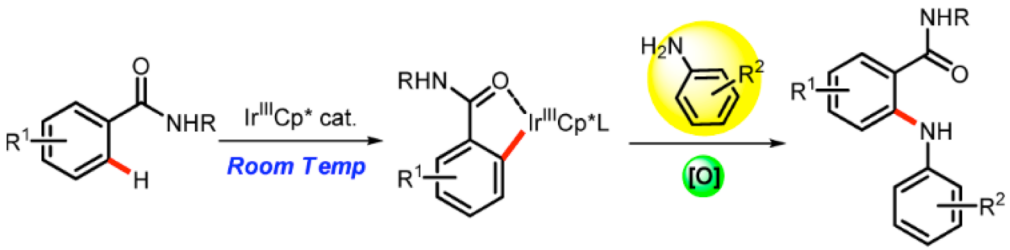


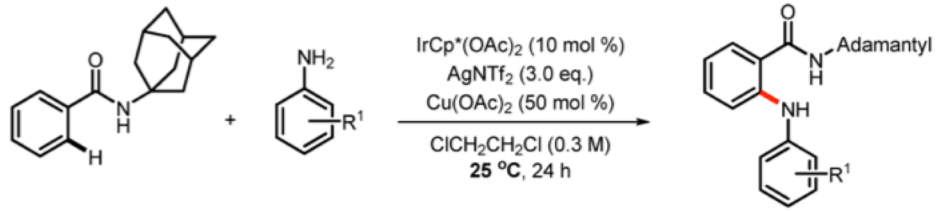

43%

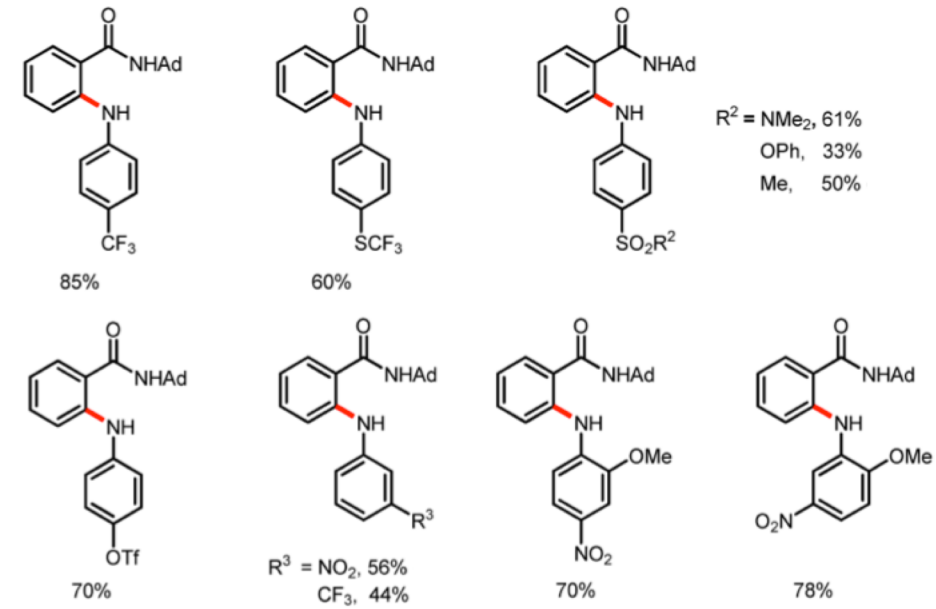



98%

# Amination with Anilines

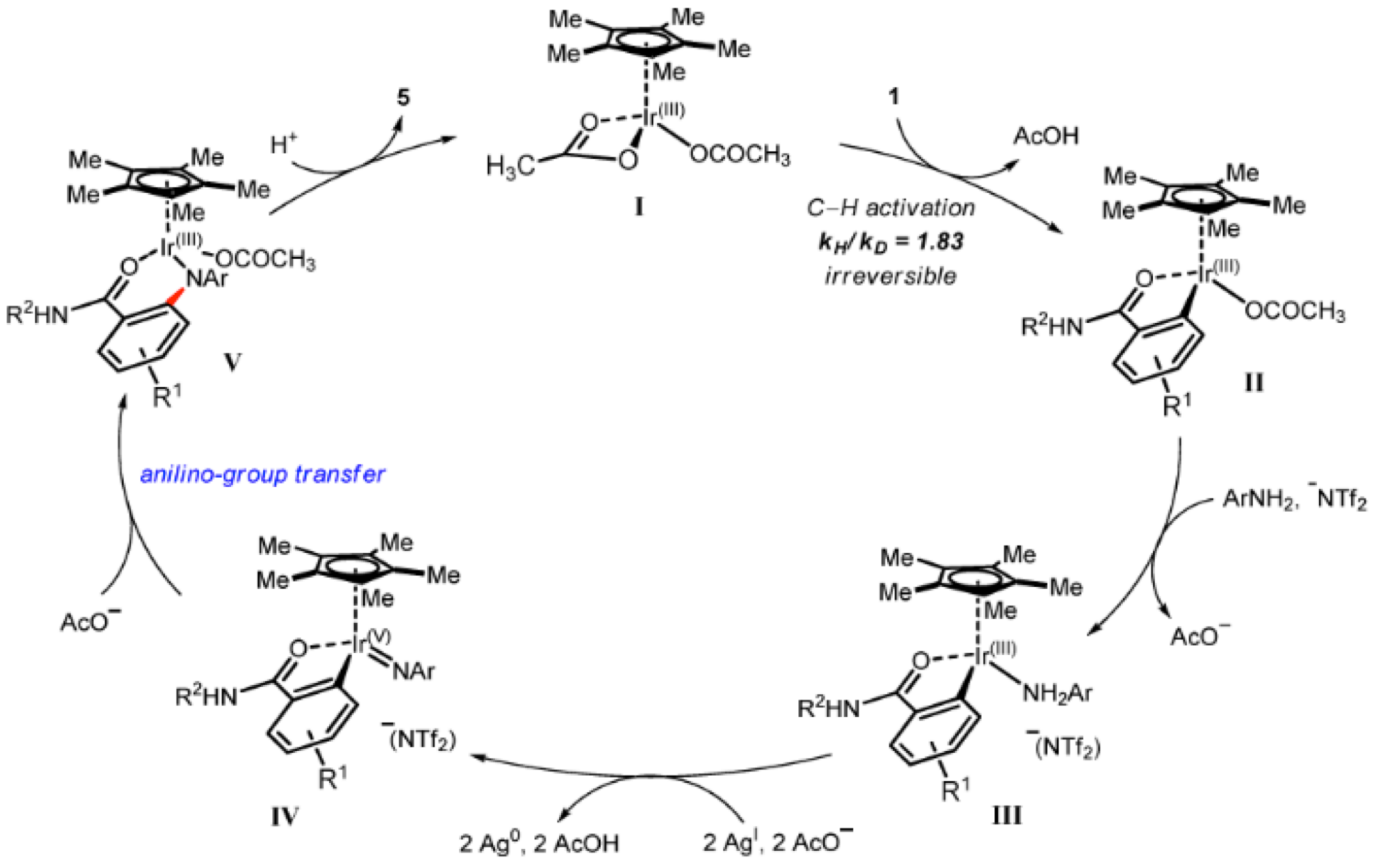


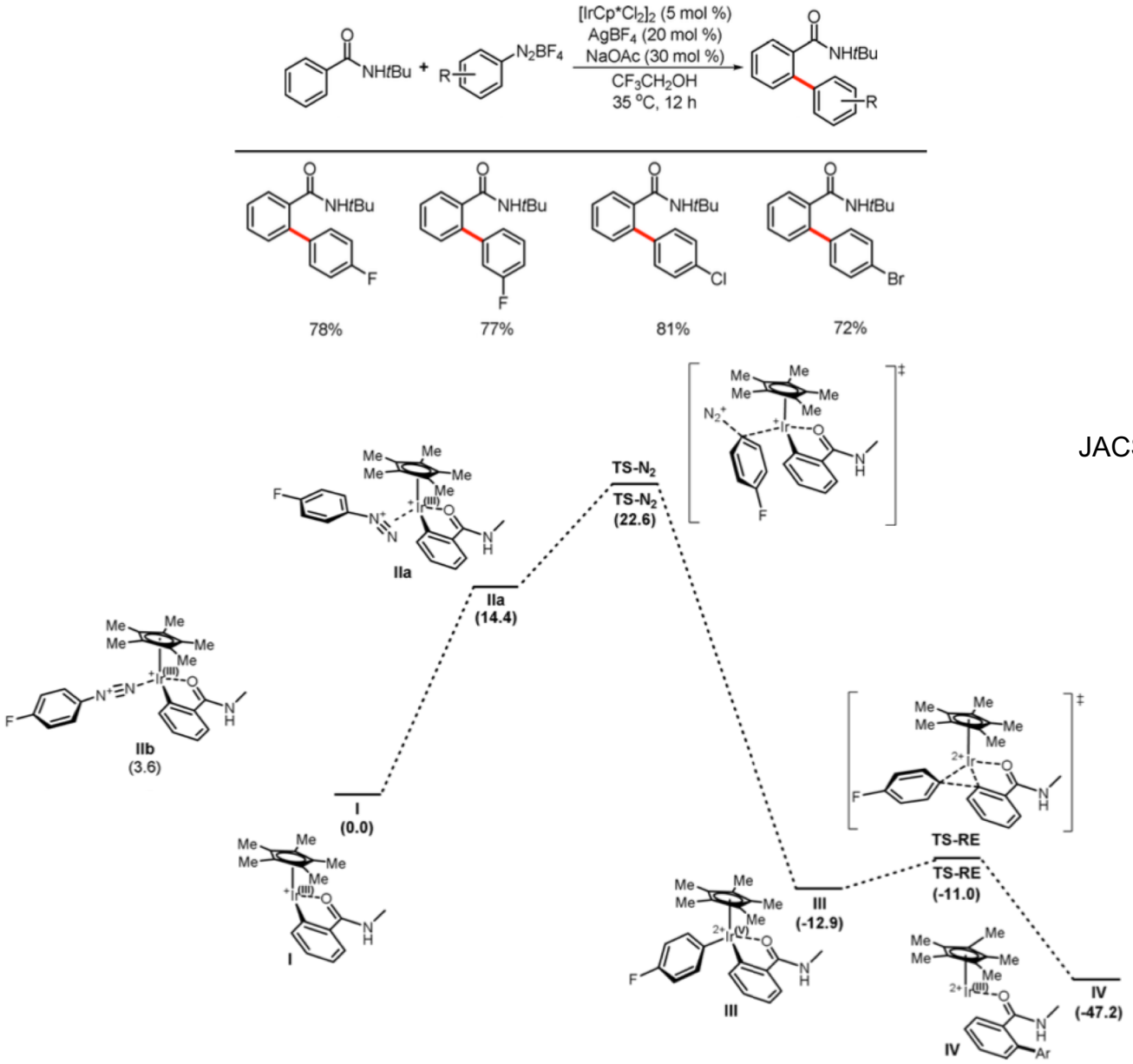




JACS **2014**, 5904

# Amination with Anilines

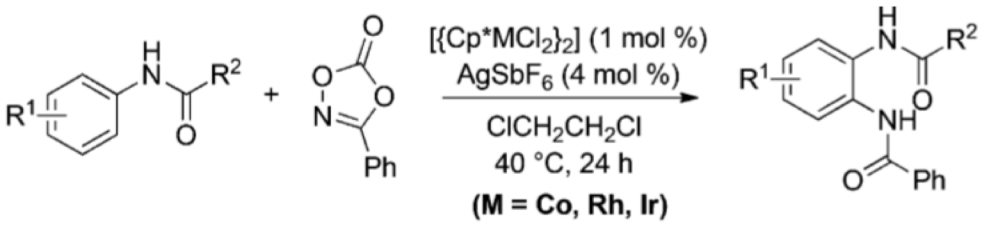


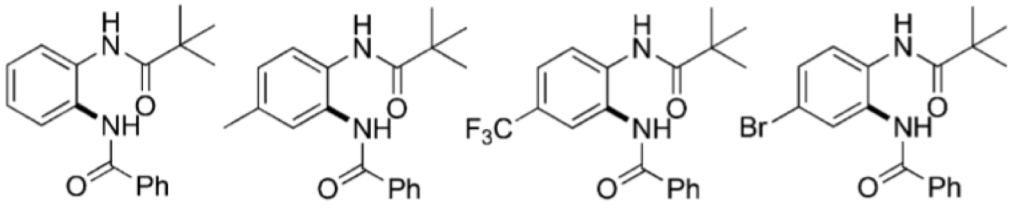
# Aryldiazonium



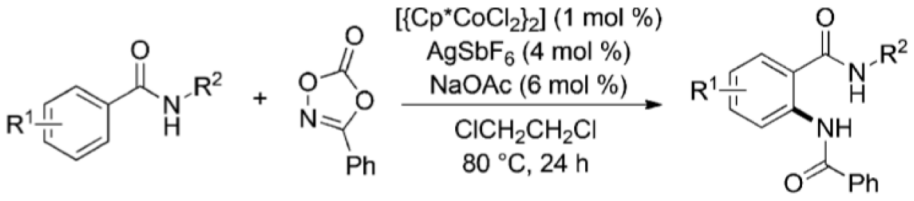

JACS **2015**, 8584

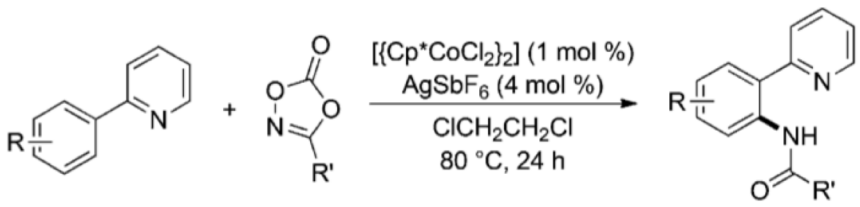
# Dioxazalones



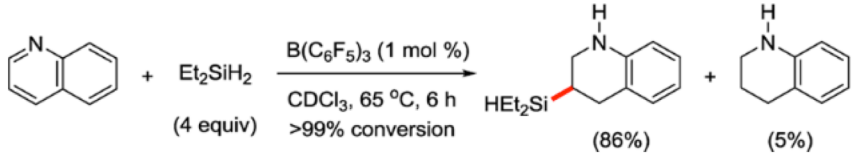
| Co: 79% | Co: 78% | Co: 83% | Co: 67% |
|---|---|---|---|
| Rh: n.r. | Rh: n.r. | Rh: n.r. | Rh: n.r. |
| Ir: 22% | Ir: 39% | Ir: 23% | Ir: 25% |

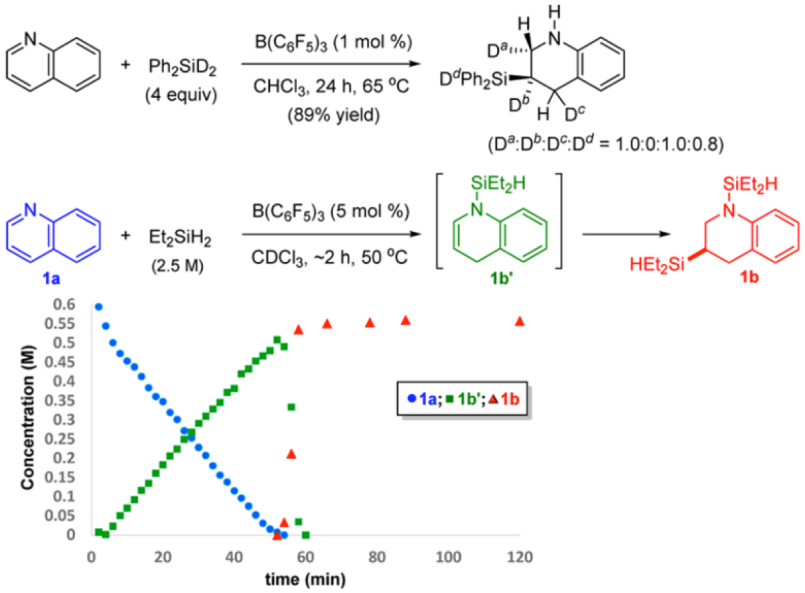


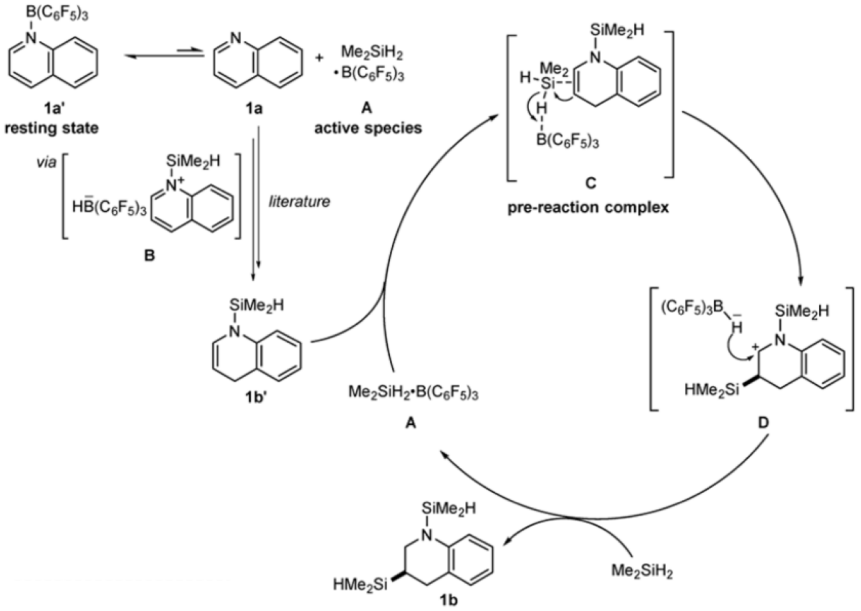




Angew. Chem. **2015**, 14103

# Heteroarene Dearomatization

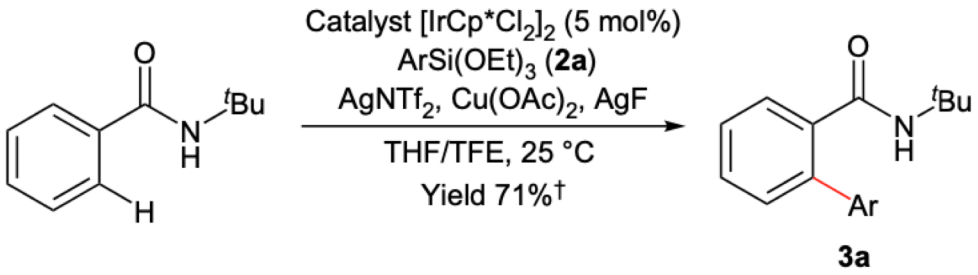


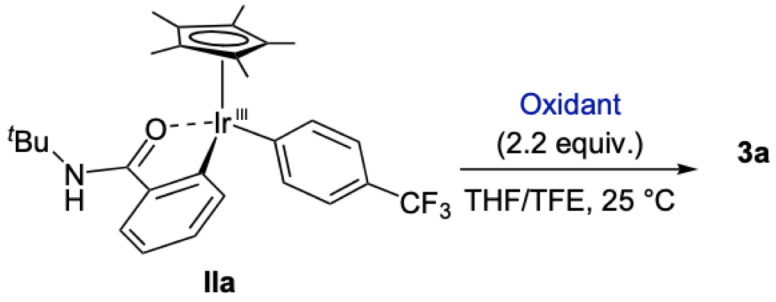




JACS **2014**, 16780

# Oxidatively Induced Reductive Elimination

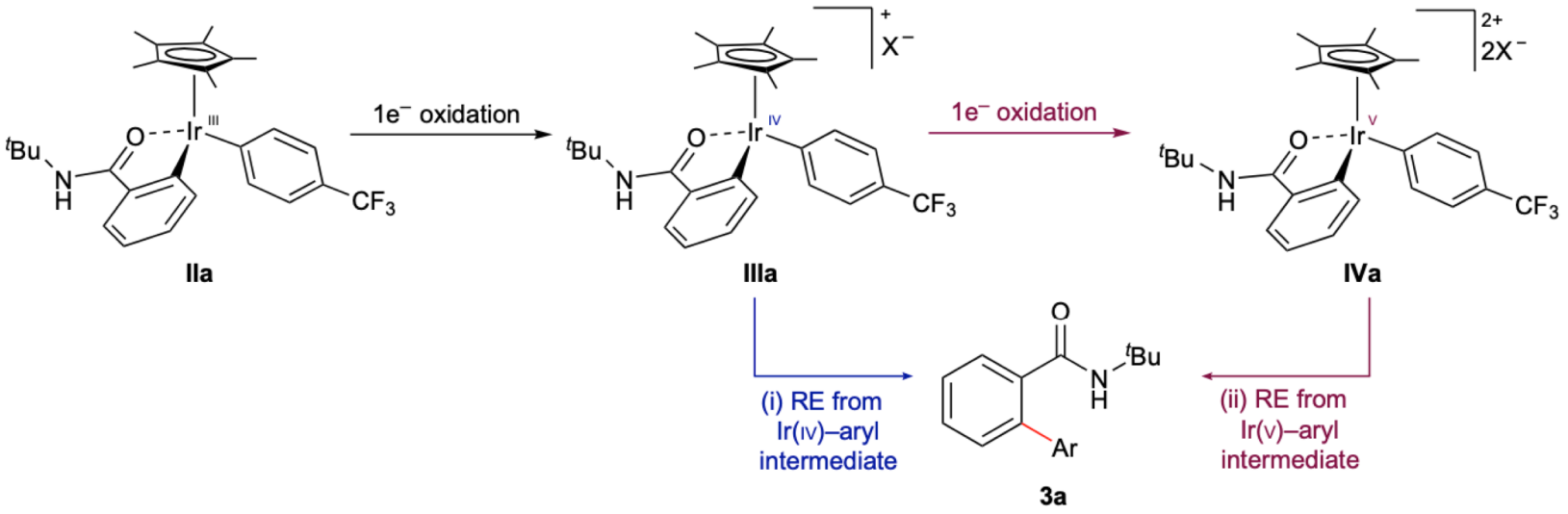


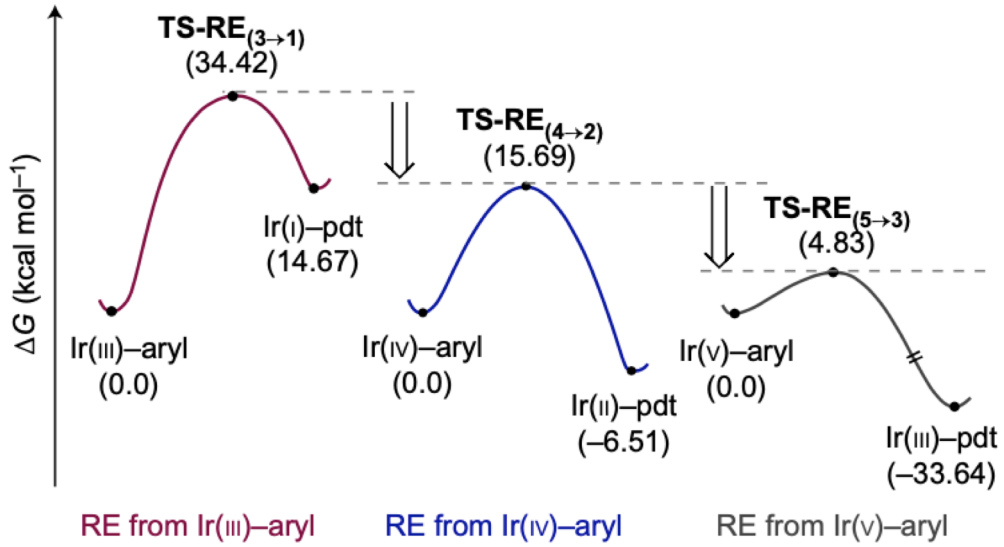




| Oxidant | AgF | AgOAc | AgOTFA | $AgNTf_2$ | None |
|---|---|---|---|---|---|
| Yield (%) | 86 | 84 | 83(76§) | 35 | NR |

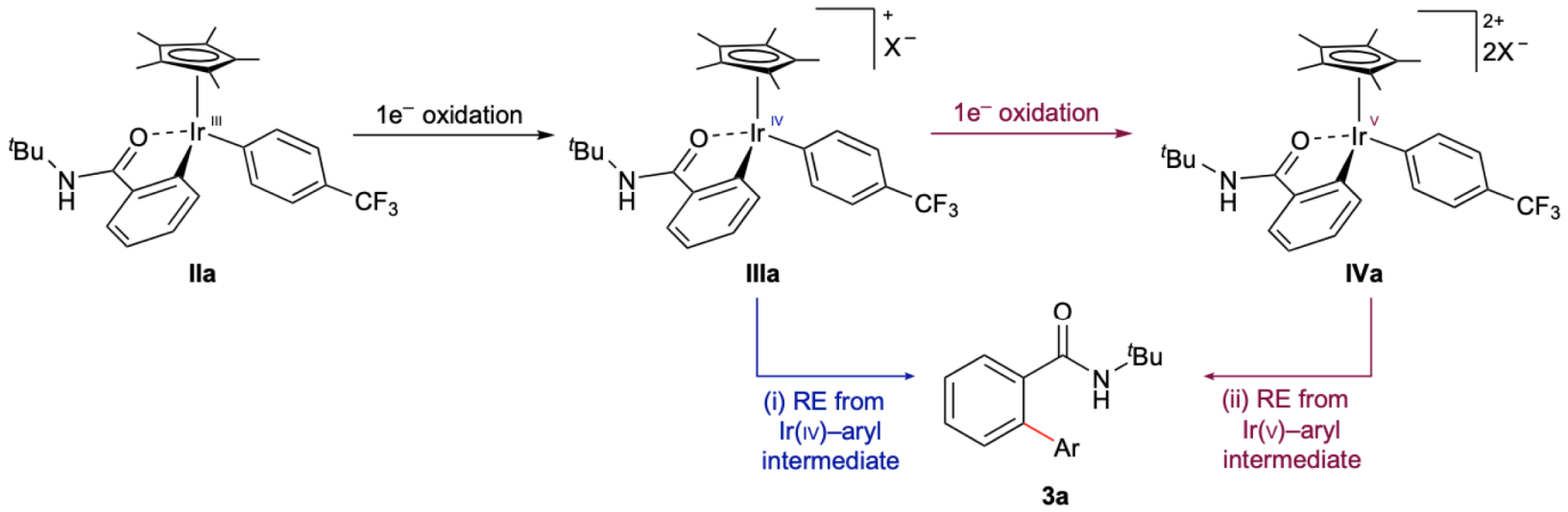
Nature Chem. **2018**, 218-224

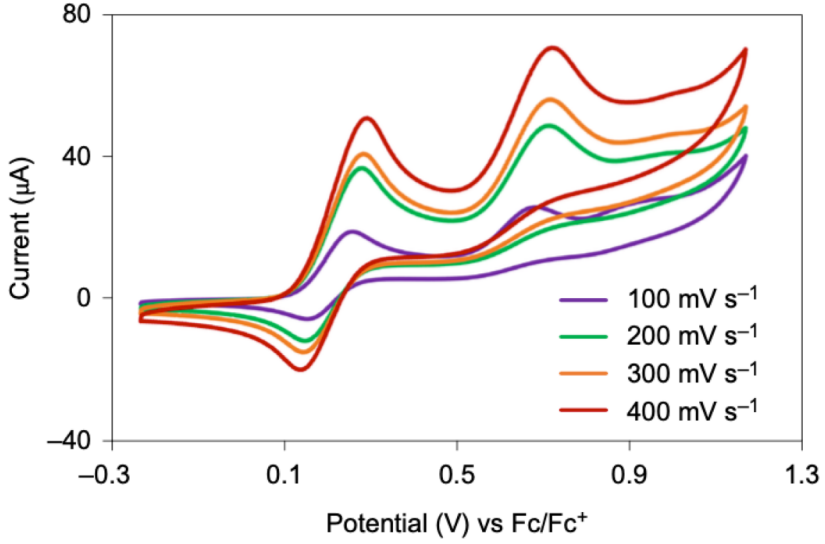
# Oxidatively Induced Reductive Elimination

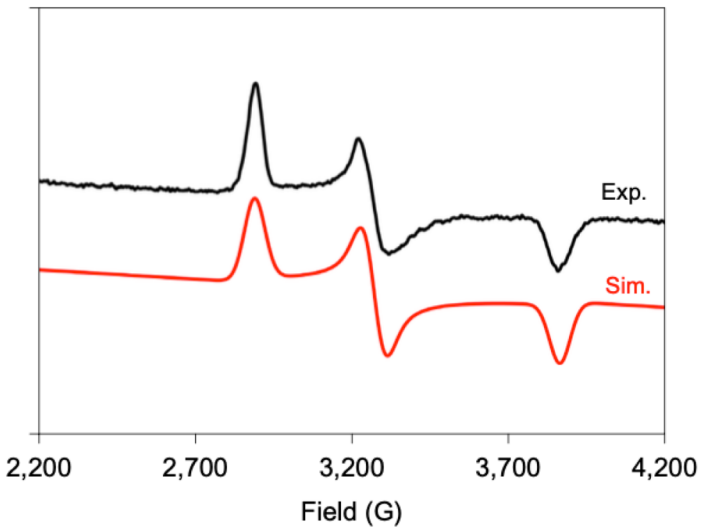


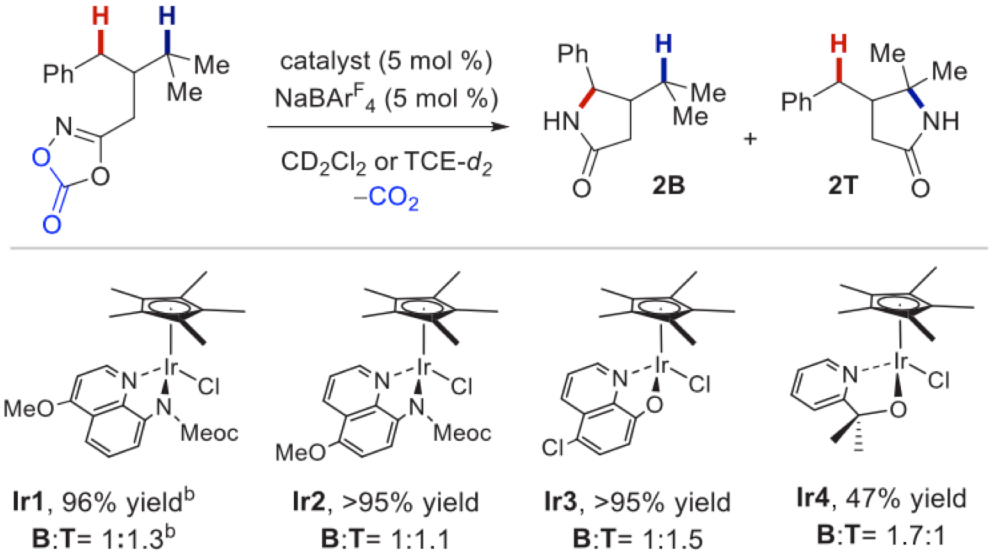
# Oxidatively Induced Reductive Elimination

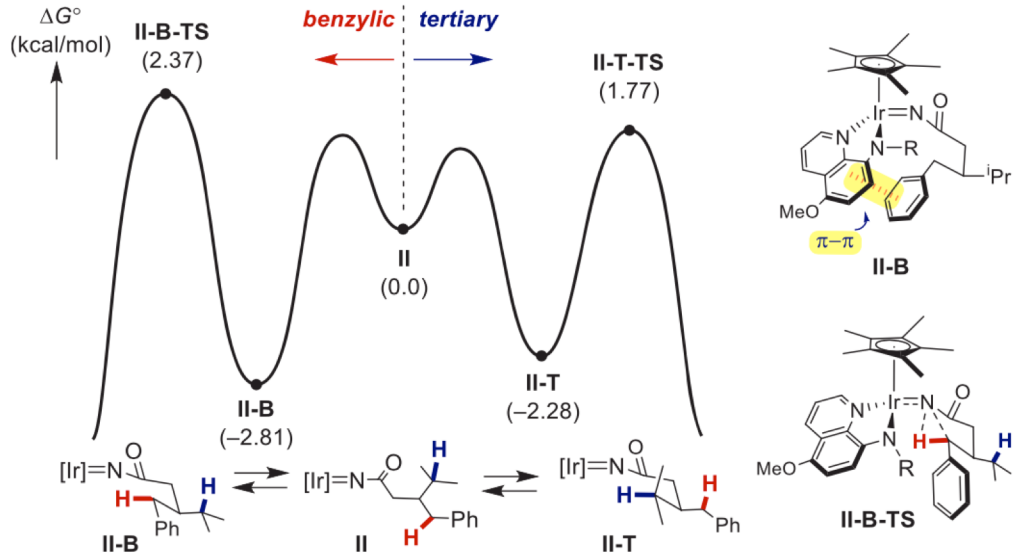


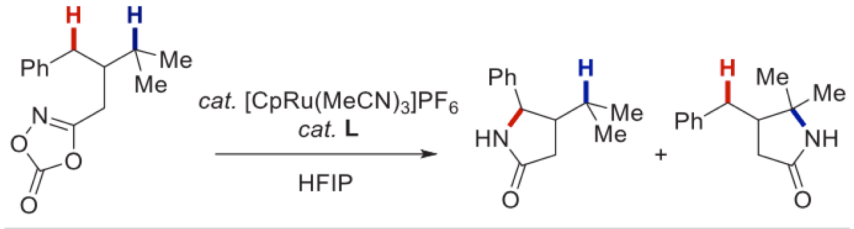
# Secondary Coordination Sphere

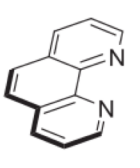


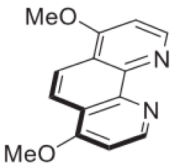

JACS **2019**, 15356

# Secondary Coordination Sphere

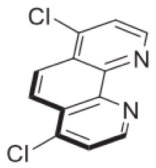


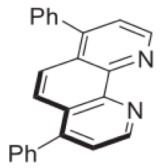
**L1**
88% yield, **14**:1



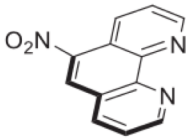
**L2**
78% yield, **>20**:1



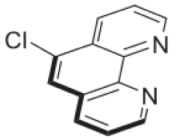
**L3**
84% yield, **>20**:1



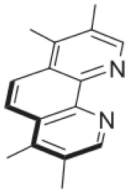
**L4**
95% yield, **>20**:1



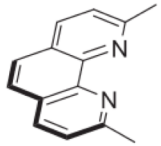
**L5**
>95% yield, **>20**:1



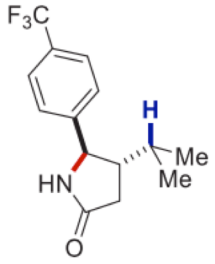
**L6**
90% yield, **>20**:1



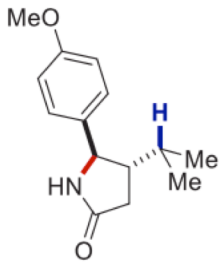
**L7**
91% yield, **>20**:1



**L8**
76% yield, **20**:1

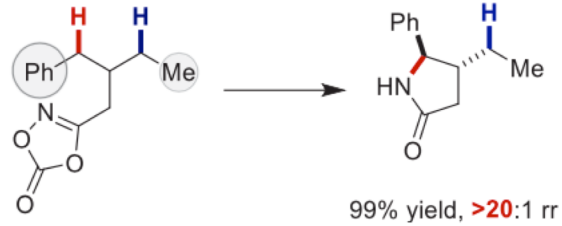


77% yield, **4.9**:1 rr



86% yield, **>20**:1 rr

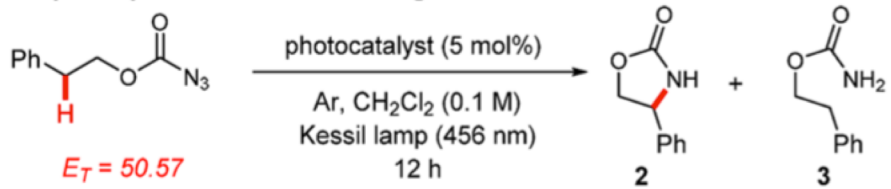
*vs. 2° C(sp³)–H bond*



99% yield, **>20**:1 rr

# Triplet Energy Tuning

**Attempts of photosensitization using azidoformate**




$E_T$ = 50.57

| entry | photocatalyst | $E_T$ (kcal/mol) | ΔG (EnT) (kcal/mol) | yield of **2** | yield of **3** |
|---|---|---|---|---|---|
| 1 | $Ir(ppy)_2(dtbbpy)(PF_6)$ (**Ir1**) | 51.0 | -0.43 | <5 | 18 |
| 2 | $[Ir(dF(CF_3)ppy)_2(dtbbpy)](PF_6)$ (**Ir2**) | 61.0 | -10.43 | <5 | 13 |
| 3 | $Ir(ppy)_3$ (**Ir3**) | 55.4 | -4.83 | 5 | 16 |
| 4 | $Ru(bpy)_3(PF_6)_2$ (**Ru1**) | 47.7 | +2.87 | <5 | <5 |

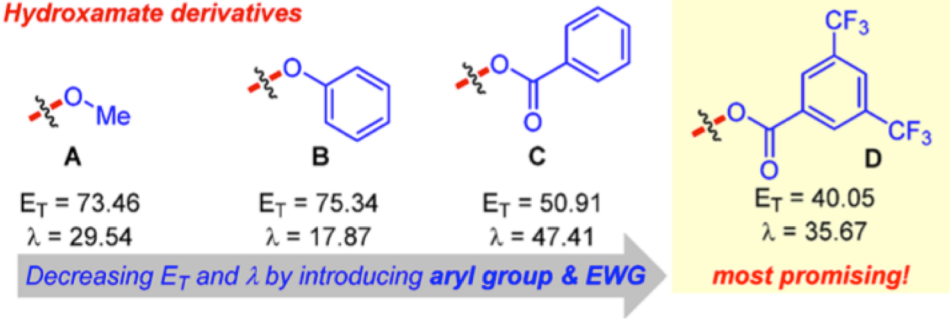

$E_T$ = 50.57, λ = 64.55

$E_T$, λ, = ?

***Challenges***

Inefficient *energy transfer?* → How to modulate $E_T$ & λ?

***Hydroxamate derivatives***




| A | B | C | D |
|---|---|---|---|
| $E_T$ = 73.46 | $E_T$ = 75.34 | $E_T$ = 50.91 | $E_T$ = 40.05 |
| λ = 29.54 | λ = 17.87 | λ = 47.41 | λ = 35.67 |

*Decreasing $E_T$ and λ by introducing **aryl group & EWG***

***most promising!***

JACS **2020**, 5811

# Triplet Energy Tuning