Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM ON C–H ACTIVATION

May 30 – June 2, 2016

POSTER SESSION 1
Monday, May 30, 2016 from 6:15 pm to 7:15 pm

PO-01	**RUTHENIUM CATALYSED *META*-SELECTIVE C–H BROMINATION** Christopher J. Teskey, University of Manchester
PO-02	**CATALYTIC C(SP^3)-H HYDROALKYLATION OF INTERNAL ALKYNES USING 2,6-DIMETHYL-*N*-HETEROCYCLES CATALYZED BY A CATIONIC ALKYLHAFNIUM COMPLEX** Michael J. Lopez, Osaka University
PO-03	**PALLADIUM-CATALYZED INTRAMOLECULAR DIRECT FUNCTIONALIZATION OF CYCLOPROPANES: ACCESS TO NOVEL FUSED HETEROCYCLES** Carolyn L. Ladd, Université de Montréal
PO-04	**MECHANISTIC INSIGHTS INTO THE AU-CATALYZED ALKYNYLATION OF ARENES: EVIDENCE FOR AU^{I}/AU^{III} REDOX CATALYTIC CYCLES** Manuel Hofer, University of Zurich
PO-05	**EN ROUTE TO A PRACTICAL PRIMARY ALCOHOL DEOXYGENATION** Xi-Jie Dai, McGill University
PO-06	**GENERAL SYNTHESIS OF POLYSUBSTITUTED β-NAPHTHOLS BY A DIRECTED REMOTE METALATION STRATEGY** Jennifer Melanson, Queen's University
PO-07	**CONTROL OVER ORGANOMETALLIC INTERMEDIATE ENABLES CP*CO(III) CATALYZED SWITCHABLE CYCLIZATION TO QUINOLINES AND INDOLES** Qingquan Lu, Westfälische Wilhelms-Universität Münster
PO-08	**A CONVENIENT SYNTHESIS OF 3-ACYL-(2*H*)-INDAZOLES VIA C–H ADDITION AND CYCLIZATION OF AZOBENZENES WITH α-KETO ALDEHYDES UNDER RH(III)-CATALYST** Taejoo Jeong, Sungkyunkwan University
PO-09	**PHOSPHORAMIDATE TANTALUM CATALYZED HYDROAMINOALKYLATION: ROOM TEMPERATURE AND SOLVENT FREE C–H FUNCTIONALIZATION OF AMINES** Pierre Garcia, OmegaChem Inc.
PO-10	***ORTHO*-C–H BOND VINYLATION OF ARYLIMIDO LIGANDS BRIDGING TWO TITANIUM CENTERS** Hayato Tsurugi, Osaka University
PO-11	**C–H PROPARGYLIC AMINATION USING RHODIUM DIMERS** Johan Bartholoméüs, Université de Montréal

PO-12	CATALYTIC PARTIAL OXIDATION OF METHANE OVER PT/RH CATALYSTS SUPPORTED ON FECRALLOY Zhenni Ma, École Polytechnique Montreal
PO-13	FACTORS DICTATING sp^2 AND sp^3 C–H BOND ACTIVATION AT CP*CO(I) CENTERS Christopher A. Bradley, Mount St. Mary's University
PO-14	C–H BOND ACTIVATION WITH A SILICA-SUPPORTED CATALYST FOR THE SYNTHESIS OF EXTENDED PI-CONJUGATED ORGANIC SMALL MOLECULES FOR USE IN ORGANIC ELECTRONICS Seth M. McAfee, University of Calgary
PO-15	TOWARDS THE SYNTHESIS OF 1,3,4-BENZOTRIAZEPIN-2-ONES AND PYRROLO[1,2][1,3,4]BENZOTRIAZEPIN-6-ONES TURN MIMICS Antoine Douchez, Université de Montréal
~~PO-16~~	~~TRANSITION METAL CATALYZED DIRECT ORTHO-AROYLATION OF ARENE C–H BONDS THROUGH AEROBIC OXIDATIVE COUPLING REACTION~~ ~~Bhavin V. Pipaliya, National Institute of Pharmaceutical Education and Researeh~~
PO-17	A GENERAL PLATFORM FOR THE SYNTHESIS OF 1,2-OXY-AMINO ARENES BY A BIO-INSPIRED COUPLING OF PHENOLS AND AMINES Kenneth Virgel N. Esguerra, McGill University
PO-18	IRON-MEDIATED OXIDATIVE C–H COUPLING OF ARENES AND ALKENES DIRECTED BY SULFUR: A NOVEL ROUTE TO DIHYDROBENZOFURANS Craig W. Cavanagh, University of Manchester
PO-19	COMPUTATIONAL MECHANISTIC STUDY OF RHODIUM-CATALYZED C–H AMINATION REACTIONS USING *N*-MESYLOXYCARBAMATES Emna Azek, Université de Montréal
PO-20	ONE-POT SYNTHESIS OF POLYSUBSTITUTED TETRAHYDRONAPHTHYRIDINES VIA MICHAEL ADDITION AND INVERSE ELECTRON DEMAND DIELS–ALDER REACTION Jabrane Jouha, Université d'Orléans/Université Sultan Moulay Slimane
PO-21	RECENT DEVELOPMENT IN THE METAL-FREE CATALYTIC CSP^2-H BOND ACTIVATION AND BORYLATION BY FRUSTRATED LEWIS PAIRS Étienne Rochette, Université Laval
PO-22	RH(III)-CATALYZED ALLYLATION OF ENOL CARBAMATES WITH ALLYLIC CARBONATES Satyasheel Sharma, Sungkyunkwan University
PO-23	METAL-CATALYSED *TRANS*-CARBOMETALLATIVE CYCLIZATIONS OF ALKYNYL ELECTROPHILES Connor Yap, University of Nottingham

PO-24	GOLD CATALYZED TANDEM REACTIONS OF AMIDE-ALDEHYDE-ALKYNE COUPLING AND CYCLIZATION SYNTHESIS OF 2,4,5-TRISUBSTITUTED OXAZOLES Pierre Querard, McGill University
PO-25	COBALT(III)-CATALYZED REDOX-NEUTRAL SYNTHESIS OF UNPROTECTED INDOLES FEATURING AN N–N BOND CLEAVAGE Andreas Lerchen, Universität Münster
PO-26	A DIRECTED *ORTHO* METALATION APPROACH TO UNUSUALLY SUBSTITUTED INDAZOLE HETEROCYCLES John Fu Cullen, Queen's University
PO-27	C7-ALLYLATION OF INDOLINES WITH ALLYLIC CARBONATES UNDER RHODIUM CATALYSIS Jihye Park, Sungkyunkwan University
PO-28	RHODIUM-CATALYZED DESYMMETRATIVE REDOX ISOMERIZATION OF CYCLOHEXA-2,5-DIENOLS Thomas Johnson, University of Toronto
PO-29	RUTHENIUM CATALYZED C–H SILYLATION OF UNPROTECTED GRAMINES, TRYPTAMINES AND THEIR CONGENERS Carina Sollert, Uppsala University
PO-30	RHODIUM-CATALYZED INTRAMOLECULAR C–H AMINATION: SYNTHESIS OF CHIRAL OXAZOLIDINONES FROM *N*-MESYLOXYCARBAMATES Maroua Khalifa, Université de Montréal
PO-31	HARNESSING THE POWER OF C–H FUNCTIONALIZATION IN DRUG DISCOVERY Sriram Tyagarajan, Merck & Co.
PO-32	AN ELECTROPHILIC APPROACH TO THE PALLADIUM-CATALYZED CARBONYLATIVE C–H FUNCTIONALIZATION OF HETEROCYCLE Jevgenijs Tjutrins, McGill University
PO-33	SYNTHESIS OF CINNOLIN-3(2*H*)-ONES WITH AZOBENZENES AND α-DIAZO ESTERS UNDER RHODIUM CATALYSIS Sang Hoon Han, Sungkyunkwan University
PO-34	DIRECT ACCESS TO β-ARYL CARBONYL COMPOUNDS USING INDOLINES AND ALLYLIC ALCOHOLS VIA RH(III)-CATALYZED C–H ALKYLATION Sang Hoon Han, Sungkyunkwan University
PO-35	EFFICIENT IRON CATALYZED ANTI-MARKONIKOV OXIDATION OF TERMINAL OLEFINS Ritwika Ray, Indian Institute of Technology Bombay

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

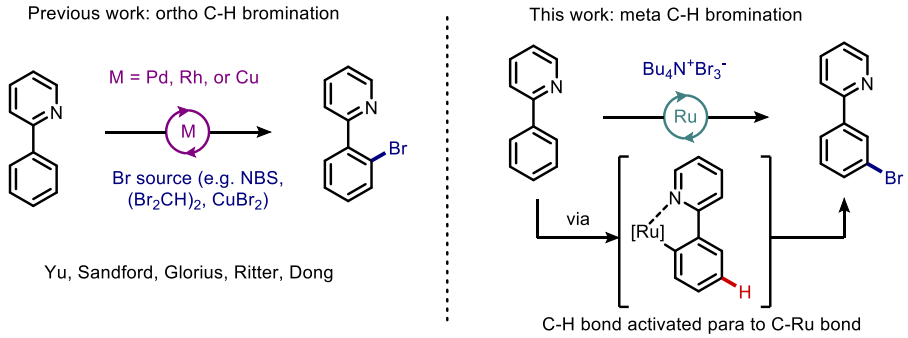
PO01 – Ruthenium Catalysed *meta*-Selective C–H Bromination

Christopher J. Teskey, Andrew Y. W. Lui, Lucas Frédéric and Michael F. Greaney*

School of Chemistry, The University of Manchester, Oxford Road, Manchester, M13 9PL, UK

E-mail: michael.greaney@manchester.ac.uk

The development of a *meta*-selective C—H bromination procedure is reported. In the presence of catalytic [{Ru(p-cymene)Cl_2}$_2$], tetrabutylammonium tribromide can be used to functionalize the *meta* C—H bond of 2-phenylpyridine derivatives, thus affording difficult to access products which are highly predisposed to further derivatization. The utility of this procedure is demonstrated with one-pot bromination/arylation and bromination/alkenylation methods to deliver *meta*-arylated and *meta*-alkenylated products, respectively, in a single step. Further investigations with other halogenating agents under ruthenium catalyzed conditions have revealed some contrasting and rather unexpected selectivity.



References

1. Teskey, C. J.; Lui, A. Y. W.; Greaney, M. F. *Angew. Chem. Int. Ed.* **2015**, *54*, 11677-11680.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO02 – Catalytic C(sp^3)-H Hydroalkylation of Internal Alkynes Using 2,6-Dimethyl-*N*-Heterocycles Catalyzed by a Cationic Alkylhafnium Complex

Michael J. Lopez, Ai Kondo, Koji Yamamoto, Hayato Tsurugi,* and Kazushi Mashima*

Department of Chemistry, Graduate School of Engineering Science, Osaka University, Toyonaka, Osaka, 560-8531, Japan

E-mail: michael@organomet.chem.es.osaka-u.ac.jp

Activation and functionalization of C—H bond assisted by transition metal complexes is one of the most atom-economical procedures to access a variety of organic compounds. We have previously reported the oxidant-free C-H activation of 2,6-lutidine followed by 1:2 cross-coupling with internal alkynes to produce carbocyclic compounds catalyzed by cationic alkyl-hafnium complexes.[1] Here, we report related dibenzylhafnium complexes **1a-d** supported by dianionic bidentate and tridentate nitrogen-based ligands serve as catalysts for the hydroalkylation of internal alkynes via C(sp^3)-H bond activation of 2,6-lutidine followed by the alkyne insertion upon activating with $[Ph_3C][B(C_6F_5)_4]$ (Figure 1). Four dibenzylhafnium complexes **1a-d** were prepared and fully characterized by ^1H and ^{13}C NMR spectroscopy together with the X-ray diffraction studies. After screening these hafnium complexes for the hydroalkylation reaction of internal dialkylacetylenes via a C(sp3)—H bond activation of 2,6-dimethyl-*N*-heterocycles, we found that the dibenzylhafnium complex **1c** (10 mol%), after activation with $[Ph_3C][(BC_6F_5)_4]$ (10 mol%), exhibited the highest catalytic activity for 1:1 cross-coupling reaction. Complex **1c** also catalyzed the regioselective hydroalkylation of unsymmetric alkynes to give a single product. In relation to the reaction mechanism, we also report the characterization and reactivity of cationic monobenzylhafnium species, which were derived by treating **1a-d** with $B(C_6F_5)_3$. In addition, kinetic studies of the catalytic reaction led to the proposal of a reaction mechanism.

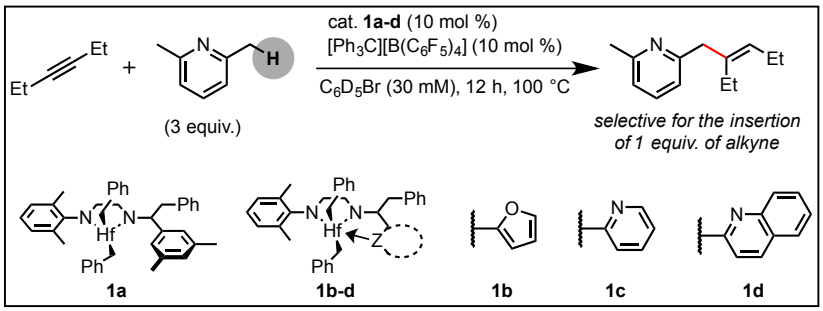


Figure 1. Catalytic C–H hydroalkylation using complexes **1a-d**

References

1. Tsurugi, H.; Yamamoto, K.; Mashima, K. *J. Am. Chem. Soc.* **2011**, 133, 732.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO03 – Palladium-Catalyzed Intramolecular Direct Functionalization of Cyclopropanes: Access to Novel Fused Heterocycles

Carolyn L. Ladd and André B. Charette*

Department of Chemistry, Faculty of Arts and Sciences, Université de Montréal, P.O. Box 6128, Station Downtown, Montréal, QC H3C 3J7 Canada

E-mail: andre.charette@umontreal.ca

Cyclopropane incorporation can offer a beneficial strategy to improve target binding and metabolic stability. Additionally, there is a growing trend within medicinal chemistry for increased saturation and molecular complexity in drug candidates. Over the last decade, direct functionalization has evolved into a powerful synthetic tool contributing to more atom economical and novel disconnections towards accessing highly complex molecular architectures. Our group has held a long-standing interest in designing novel reactions to access both cyclopropyl and heterocyclic scaffolds. More recently, we have explored palladium-catalyzed intramolecular direct arylation of cyclopropyl systems. This presentation will disclose our latest results towards accessing cyclopropyl-containing heterocycles employing palladium catalysis via a direct functionalization manifold.

References

1. Ladd, C. L.; Sustac Roman, D.; Charette, A. B. *Org. Lett.* **2013**, *15*, 1350.
2. Ladd, C. L.; Sustac Roman, D.; Charette, A. B. *Tetrahedron* **2013**, *69*, 4479.
3. Ladd, C. L.; Belouin, A. V.; Charette, A. B. *J. Org. Chem.* **2016**, *81*, 256.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

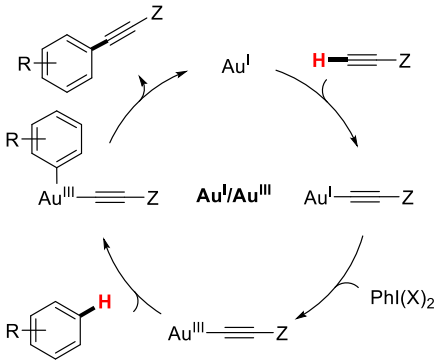
PO04 – Mechanistic Insights into the Au-Catalyzed Alkynylation of Arenes: Evidence for Au^{I}/Au^{III} Redox Catalytic Cycles

Manuel Hofer, Teresa de Haro, Enrique Gomez-Bengoa, Roopender Kumar and Cristina Nevado*

Department of Chemistry, Faculty of Science, University of Zurich, Winterthurerstrasse 190, 8057 Zurich, Switzerland

E-mail: manuel.hofer@chem.uzh.ch

Au^{I}/Au^{III}-catalyzed, oxidative cross-coupling reactions have been developed in recent years as a powerful tool for C-C and C-X bond formation. However, the mechanistic understanding of these transformations is still limited and detailed investigations to elucidate the mechanism are rare.[1] Given our going interest in Au^{I}/Au^{III} chemistry,[2] we decided to investigate the mechanism of the gold catalyzed alkynylation of arenes. This reaction enables the coupling of Csp^2-centers of electron rich arenes with Csp-centers of electron deficient terminal alkynes in presence of gold as catalyst and $PhI(OAc)_2$ as stoichiometric oxidant.[3] Kinetic analysis, NMR monitoring of reaction mixtures, control experiments and DFT calculations, have unravelled a sequence of steps to generate the product: 1) Transfer of the alkyne to the gold(I) complex via C-H activation; 2) Oxidation to an alkynylgold(III) complex by an *in situ* generated oxidant; 3) C-H Activation of the arene on the gold(III) oxidation state and subsequent reductive elimination. The reactivity of the gold(III) intermediates is governed by the anionic ligands: only the acetato ligands are displaced by the arene yielding the Csp^2-Csp coupling products, while chloride ligands show no reactivity thus highlighting the importance of catalyst and oxidant speciation.[4]



References

1. Ball, L. T.; Lloyd-Jones, G. C.; Russell, C. A. *J. Am. Chem. Soc.* **2014**, *136*, 254.
2. (a) Hofer, M.; Nevado, C. *Eur. J. Inorg. Chem.* **2012**, *9*, 1338; (b) Hofer, M.; Nevado, C. *Tetrahedron* **2013**, *69*, 5751; (c) Hofer, M.; Nevado, C. *Organometallics* **2014**, *33*, 1328.
3. De Haro, T.; Nevado, C. *J. Am. Chem. Soc.* **2010**, *132*, 1512.
4. Hofer, M.; De Haro, T.; Gomez-Bengoa, E.; Kumar, R.; Nevado, C. *Submitted for publication*

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO05 – En Route to A Practical Primary Alcohol Deoxygenation

Xi-Jie Dai and Chao-Jun Li*

Department of Chemistry and FQRNT Center for Green Chemistry and Catalysis, McGill University, 801 Sherbooke Street West, Montréal QC H3A 0B8, Canada

E-mail: cj.li@mcgill.ca

A long-standing scientific challenge in the field of alcohol deoxygenation has been the direct catalytic sp^3 C–O defunctionalization with high selectivity and efficiency, in the presence of other functionalities, such as free hydroxyl groups and amines widely present in biological molecules. Herein, we propose a catalytic late-transition-metal-catalyzed redox design, on the basis of dehydrogenation/Wolff-Kishner (WK) reduction, to simultaneously tackle the challenges regarding step economy and selectivity. The early development of our hypothesis focuses on an iridium-catalyzed process for mostly activated alcohols, which dictates harsh reaction conditions, and thus limits its synthetic utility. Later, a significant advancement has been made by employing a ruthenium complex on aliphatic primary alcohols, with good functional group tolerance and exclusive selectivity under practical reaction conditions. Overall, our current method provides a practical redox-based approach to the direct sp^3 C–O defunctionalization of aliphatic primary alcohols.

References

1. Huang, J.-L.; Dai, X.-J.; Li, C.-J. *Eur. J. Org. Chem.* **2013**, 6496.
2. Dai, X.-J.; Li, C.-J. *J. Am. Chem. Soc.* **2016**, *submitted*.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

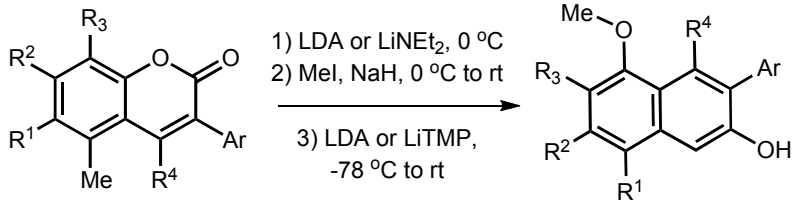
PO06 – General Synthesis of Polysubstituted β-Naphthols by a Directed Remote Metalation Strategy

Jignesh Patel, Johnathan Board, M. Selim Hossain, Marju Laars, Jennifer Melanson, and Victor Snieckus*

Department of Chemistry, Queen's University, 99 University Avenue, Kingston (Ontario), Canada K7L 3P5; Snieckus Innovations, Innovation Park, 945 Princess Street, Kingston, ON K7L 3N6, Canada

E-mail: victor.snieckus@queensu.ca

Naphthols are useful synthetic intermediates and exhibit interesting biological activities.[1] We disclose an efficient and regioselective route to polysubstituted β-naphthols (**2**) from readily accessible coumarins (**1**) involving a directed remote metalation (DReM) tactic. The scope of the DReM reaction will be described and mechanistic consideration will be discussed.



1 **2**

References

1. (a) Eich, E.; Pertz, H.; Kaloga, M.; Schulz, J.; Fesen, M. R.; Mazumder, A.; Pommier, Y. *J. Med. Chem.* **1996**, *39*, 86; (b) Ward, R. S. *Nat. Prod. Rep.* **1995**, *12*, 183; (c) Ukita, T.; Nakamura, Y.; Kubo, A.; Yamamoto, Y.; Takahashi, M.; Kotera, J.; Ikeo, T. *J. Med. Chem*. **1999**, *42*, 1293.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

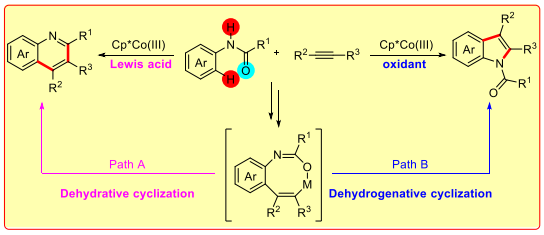
PO07 – Control Over Organometallic Intermediate Enables Cp*Co(III) Catalyzed Switchable Cyclization to Quinolines and Indoles

Qingquan Lu, Suhelen Vásquez-Céspedes, Tobias Gensch, and Frank Glorius*

Organisch-Chemisches Institut, Westfälische Wilhelms-Universität Münster Corrensstraße 40, 48149 Münster, Germany

E-mail: glorius@uni-muenster.de

Herein, we show for the first time that control over the reactive organometallic intermediate enables the switchable synthesis of quinoline and indole from amides and alkynes through C–H activation using Cp*Co(III). The keys to this strategy are: 1) introducing a Lewis acid to greatly accelerate the dehydrative cyclization, which can out-compete dehydrogenative cyclization; 2) tuning the directing group to facilitate the dehydrogenative cyclization and inhibit dehydrative cyclization.



References

1. Lu, Q.; Vásquez-Céspedes, S.; Gensch, T.; Glorius, F. *ACS Catal.* **2016**, *6,* 2352.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO08 – A Convenient Synthesis of 3-Acyl-(2*H*)-Indazoles via C–H Addition and Cyclization of Azobenzenes with α-Keto Aldehydes under Rh(III)-catalyst

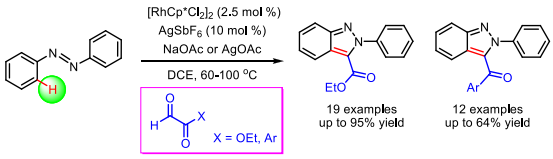
Taejoo Jeong*

School of Pharmacy, Sungkyunkwan University, Suwon 440-746, Republic of Korea

E-mail: bonbatj@nate.com

The indazole heterocycle has been recognized as a crucial structural core found in natural products and pharmaceuticals with a broad spectrum of medicinal applications.[1] In particular, the 3-acyl indazole motif is present in molecules that possess anticancer, antiemetic, viral polymerase inhibition, and anti-inflammatory activities.[2] The classical routes to 3-acyl indazoles involve (i) N-nitrosation of acetanilides followed by intramolecular cyclization onto the ortho-methylene group, (ii) multistep synthesis from isatins via hydrolysis of the amide unit, diazotization and reduction, and (iii) direct lithiation at the C3-position followed by the addition of electrophiles. Surprisingly, however, the catalytic preparation of 3-acyl indazole scaffolds remains virtually unexplored.

In continuation of our recent studies on the rhodium-catalyzed C−H functionalization and heterocycles synthesis,[3] we herein present the Rh(III)-catalyzed direct C−H addition followed by intramolecular cyclization of azobenzenes with α-keto aldehydes, such as ethyl glyoxalate and aryl glyoxals, affording 3-acyl-(2H)-indazoles.



References

1. Haddadin, M. J.; Conrad, W. E.; Kurth, M. J. *Mini-Rev. Med. Chem.* **2012**, *12*, 1293.
2. Cupissol, D. R.; Serrou, B.; Cabel, M. J. *Cancer Clin. Oncol.* 1990, 26, S23.
3. Jeong, T.; Han, S. H.; Han, S.; Sharma, S.; Park, J.; Lee, J. S.; Kwak, J. H.; Jung, Y. H.; Kim, I. S. *Org. Lett.* **2016**, *18*, 232.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO09 – Phosphoramidate Tantalum Catalyzed Hydroaminoalkylation: Room Temperature and Solvent Free C–H Functionalization of Amines

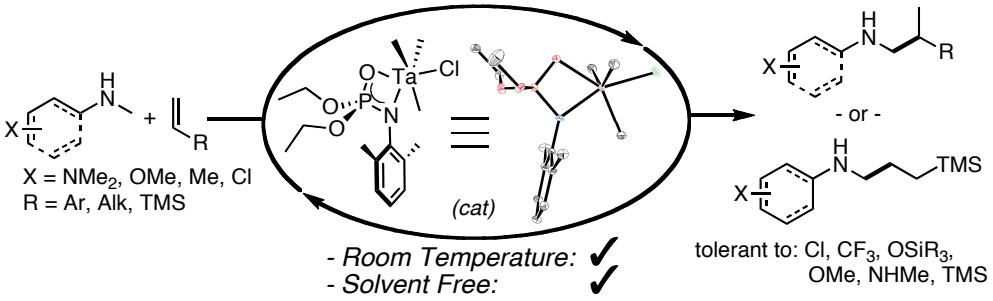
Pierre Garcia,[a] Ying Yin Lau,[b] Mitchell R. Perry,[b] and Laurel L. Schafer[b]*

[a] Omegachem, 480 rue Perreault, Lévis, QC, G6W 7V6, Canada
[b] University of British Columbia – Department of Chemistry, Vancouver, BC, V6T 1Z1, Canada

E-mail: schaferl@mail.ubc.ca

Free amino groups are ubiquitous motifs present in a range of compounds from drugs to functional materials.[1] An ideal synthesis of highly substituted amines encompasses a direct preparation from feedstock alkenes and simple amines under mild reaction conditions. Early transition-metal catalyzed hydroaminoalkylation, a C-H functionalization reaction α to nitrogen resulting in C-C bond formation achieves most of these desirable goals.[2] However all reported catalysts require harsh conditions.[3]

We have discovered that new phosphoramidate-$ClTaMe_3$ complexes promote the first example of room temperature catalyzed hydroaminoalkylation reactions.[4] The easily prepared precatalyst can be used with challenging substrates such as styrenes and dialkyl amines and is functional group tolerant (OTBS, OMe, Cl, CF_3, TMS), making this a practical, atom-economic C–H functionalization reaction. When using a vinylsilane substrate, a reversal of regioselectivity is observed. This is the first example of regioselectivity towards the linear product using a group 5 metal catalyst for hydroaminoalkylation reactions. This reaction is amenable to solvent free conditions with a remarkable efficiency.



References

1. Salvatore, R. N.; Yoon, C. H.; Jung, K. W. *Tetrahedron*, **2001**, *57*, 7785.
2. First reports of hydroaminoalkylation: a) Clerici, M. G.; Maspero, F. *Synthesis* **1980**, 305; b) Nugent, W. A.; Ovenall, D. W.; Holmes, S. J. Organometallics **1983**, *2*, 161; c) Herzon, S. B.; Hartwig, J. F. *J. Am. Chem. Soc.* **2007**, *129*, 6690.
3. Chong, E.; Garcia, P.; Schafer, L. L. *Synthesis*, **2014**, 2884.
4. Garcia, P.; Lau, Y. Y.; Perry; M. R., Schafer, L. L. *Angew. Chem. Int. Ed*. **2013**, *52*, 9144.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO10 – *ortho*-C–H Bond Vinylation of Arylimido Ligands Bridging Two Titanium Centers

Hayato Tsurugi,* Haruki Nagae, and Kazushi Mashima*

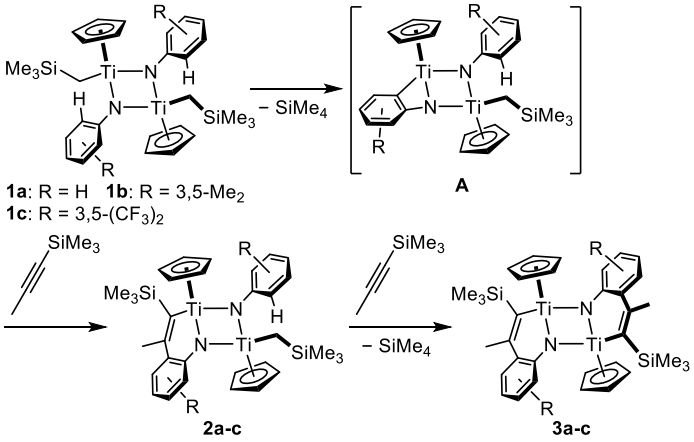
Department of Chemistry, Graduate School of Engineering Science, Osaka University, Toyonaka, Osaka 560-8531, Japan

E-mail: tsurugi@chem.es.osaka-u.ac.jp; mashima@chem.es.osaka-u.ac.jp

N-Arylimido groups ($[Ar\text{-}N]^{2-}$) have been extensively utilized as ancillary ligands for stabilizing high-valent early transition metal complexes. Functionalization of the aryl group for the (*N*-arylimido)metal complexes is an important target to control the reactivity of the metal centers; however, direct C–H substitution of the aryl ring is difficult for the (*N*-arylimido)metal complexes due to the distal position of the aryl ring from the metal center. Herein, we report that the *ortho*-C–H vinylation on the *N*-arylimido fragment proceeds by using a μ-imido-bridged dinuclear titanium scaffold, and the reaction mechanism was elucidated by the kinetic study as well as the DFT calculation.

A series of dialkyl complexes of doubly *N*-arylimido-bridged titanium complexes, $[CpTi(CH_2SiMe_3)(\mu\text{-}NAr)]_2$ (**1a-c**), was prepared by the reaction of $[CpTiCl(\mu\text{-}NAr)]_2$ with $LiCH_2SiMe_3$. We found that complexes **1a-c** reacted with 1-(trimethylsilyl)propyne at 100 °C to form six-membered metallacycle complexes **3a-c** through *ortho*-C-H bond metallation of the μ-(*N*-arylimido) ligands and subsequent insertion of 1-(trimethylsilyl)propyne (Scheme 1). Upon monitoring the ^1H NMR spectrum of the reaction mixture of **1a** and 1-(trimethylsilyl)propyne in C_6D_6 at 100 °C, we detected non-symmetric titanacycle complex **2a** at the early stage, and then **3a** was gradually formed with decreasing the signals for **2a**. DFT calculation for the whole reaction process revealed that deformation of the Ti_2N_2 core was a key event to minimize the energy of the transition state for the C-H bond metallation before forming the intermediate **A** (Figure 1).

Scheme 1. Formation of azatitanacycle complexes **3a-c**.



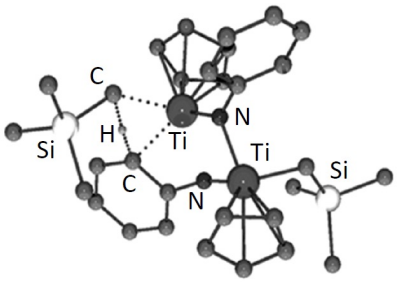


Figure 1. Transition state for C-H bond activation.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO11 – C–H Propargylic Amination Using Rhodium Dimers

Johan Bartholoméüs and Hélène Lebel*

Department of Chemistry, Faculty of Arts and Sciences, Université de Montréal, P.O. Box 6128, Station Downtown, Montréal, QC H3C 3J7, Canada

E-mail: helene.lebel@umontreal.ca

Our group has recently developed a method for the formation of C–N bonds by direct functionalization of C–H bonds using metal nitrene species. *N*-mesyloxycarbamates were used with a rhodium dimer to react with C–H bonds and thioethers to produce respectively chiral benzylic amines and chiral sulfilimines.[1,2] This method was extended to the synthesis of propargylic amines. The latter are versatile synthetic blocks for the formation of diverse heterocycles and are also found in many biologically important compounds. They are typically synthesized by the addition of an acetylide to an imine, or by reduction of ketamine.[3] In comparison, the direct functionalization of propargylic C–H bonds is an attractive alternative method which does not use prefunctionalized substrates. This poster presents the stereoselective amination of propargylic substrates using a chiral *N*-mesyloxycarbamate and chiral rhodium dimer catalysts. A variety of chiral enantioenriched propargylic amines were produced in good yields and high levels of stereoselectivity. The optimization of the reaction conditions and the scope of the reaction will be discussed. Some mechanistic aspects of the reaction will also be presented.

References:

1. Lebel, H. *et al*. *Chem*. *Commun*. **2012**, 7799
2. Lebel, H. *et al*. *J*. *Org*. *Chem*. **2015**, 3572
3. Trost, B. M.; Weiss, A. H. *Adv*. *Synth*. *Catal*. **2009**, 351.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO12 – Catalytic Partial Oxidation of Methane Over Pt/Rh Catalysts Supported on FeCralloy

Zhenni Ma, Daria C. Boffito and Gregory S. Patience*

Department of Chemical Engineering, École Polytechnique Montreal, PO Box 6079, Station Downtown, Montréal, QC H3C 3A7 Canada

E-mail: zhenni.ma@polymtl.ca

Micro-Gas-to-Liquids technology (GtL) reduces flared natural gas and emissions while producing valuable diesel. Integrating a high pressure syngas step with Fischer-Tropsch (FT) in a single vessel reduces investment and operating costs to synthesize GtL liquids. Methane catalytic partial oxidation (CPOX) to produce syngas for FT is an economic opportunity for micro-refineries. Many metals and metal oxides selectively convert natural gas to CO and H_2 but they also form coke, which must be removed intermittently otherwise it deactivates the catalyst and fouls reactors and process lines.

FeCralloy woven fibres are promising supports to partially oxidize methane because they resist high temperatures, are highly conductive, and can be molded into shapes. So far we successfully dispersed Pt and Rh over the surface of FeCralloy fibres that we coated MgO via solution combustion synthesis. The selectivity to syngas of these catalysts was better than commercial Pt gauzes at 900 °C and from 0.1 MPa and 2 MPa. Over Pt/Rh/MgO FeCralloy catalysts, at 2MPa and a residence time of 0.3 s, syngas yield was 50% CO with a H_2/CO ratio of 2. All the oxygen was consumed for all experiments, which is critical for the FT step that requires reducing conditions.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO13 – Factors Dictating sp^2 and sp^3 C–H Bond Activation at Cp*Co(I) Centers

John Andjaba, Katie Dalphon, Jesse W. Tye, and Christopher A. Bradley*

Department of Science, Mount St. Mary's University, 16300 Old Emmitsburg Road, Emmitsburg, MD, USA

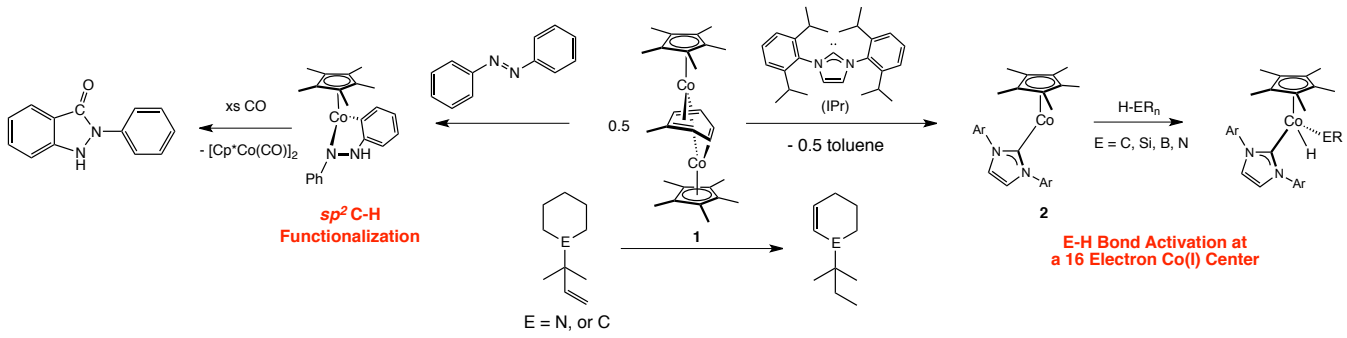
E-mail: cbradley@msmary.edu

An active area of interest in our group has centered on the generation of unsaturated Cp*Co(I) fragments for catalytic and stoichiometric C–H bond activation. In one case, the triple decker complex [$(Cp^*Co)_2$-μ-(η^4:η^4-toluene)] (**1**), a ready source of Cp*Co(I) equivalents, mediates sp^3 C–H oxidative addition and subsequent transfer dehydrogenation in activated substrates at ambient temperature. In an effort to understand the C–H bond cleavage event, we have explored reaction of the sandwich complex with a series of substrates to determine what factors influence oxidative activation in the system. Spin state effects in the intermediates and their impact on the barriers to oxidative addition will be discussed.

The experimental and computational study of sp^2 C–H activation with **1** has also been investigated with arene substrates. In particular, stoichiometric addition of azobenzene results in facile arene C–H activation which, when coupled with carbon monoxide addition, results in both C–N and C–C bond formation to produce a heterocycle.

Recently, we have also isolated and characterized the 16 electron complex Cp*Co(IPr) (IPr = [1,3-bis(2,6-diisopropylphenyl)imidazole-2-ylidene]) (**2**). The compound is a triplet species that readily undergoes oxidative addition of dihydrogen to provide a dihydride. Given this reactivity, we have investigated thermal and photochemical sp^2 and sp^3 C-H bond activation with the unsaturated fragment. Computational analysis of the systems will be discussed, along with comparative reactivity of **2** with other E-H (E = B, N, Si) bonds.

Collectively, these studies have provided valuable insight into small molecule activation and the factors that dictate C–H bond activation at 14 and 16 electron Cp*Co(I) fragments.



Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

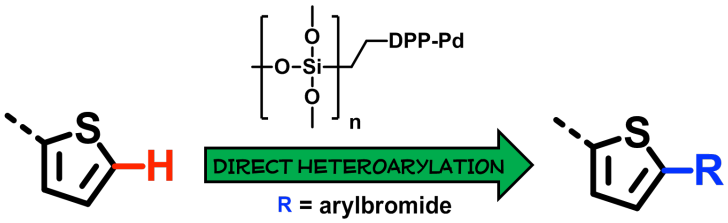
PO14 – C–H Bond Activation with a Silica-Supported Catalyst for the Synthesis of Extended pi-Conjugated Organic Small Molecules for Use in Organic Electronics

Seth M. McAfee, Arthur D. Hendsbee, Abby-Jo Payne, and Gregory C. Welch*

Department of Chemistry, University of Calgary, 2500 University Drive N.W., Calgary, Alberta, Canada T2N 1N4

E-mail: seth.mcafee@ucalgary.ca

A synthetic protocol has been developed for the synthesis of extended pi-conjugated organic small molecules employing C–H bond activation and a silica-supported catalyst. This silica-supported catalyst has been shown to be both active and robust, matching or exceeding the performance of traditional homogeneous Pd catalysts. This approach has led to the synthesis of a large array of new pi-conjugated materials demonstrating the advantages of both the silica-supported catalyst and C–H bond activation over traditional Pd-catalyzed Stille and Suzuki cross-coupling reactions.



References

1. McAfee, S.; McCahill, J.; Macaulay, C.; Hendsbee, A.; Welch, G. *RSC Advances.* **2015**, *5*, 26097.
2. Hendsbee, A.; McAfee, S.; Sun, J-P.; McCormick, T.; Hill, I.; Welch, G. *J Mater Chem C.* **2015**, *3*, 8904.
3. McAfee, S.; Topple, J.; Payne, A-J.; Sun, J-P.; Hill, I.; Welch, G. *ChemPhysChem.* **2015**, *6*, 1190.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

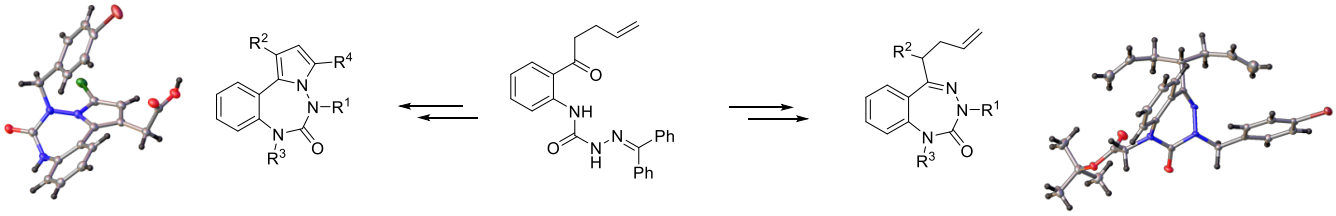
PO15 – Towards the Synthesis of 1,3,4-Benzotriazepin-2-ones and Pyrrolo[1,2][1,3,4]benzotriazepin-6-ones Turn Mimics

Antoine Douchez and William D. Lubell*

Department of Chemistry, Faculty of Arts and Sciences, Université de Montréal, P.O. Box 6128, Station Downtown, Montréal, QC, Canada H3C 3J7

E-mail: william.lubell@.umontreal.ca

1,3,4-Benzotriazepin-2-ones have been pursued due to their interesting properties, medicinal applications and relationship with benzodiazepinones.[1] Our presentation will describe an approach designed to synthesize highly substituted triazepin-2-ones using a common linear precursor. X-ray crystallographic analysis of specific benzotriazepin-2-ones will be presented to demonstrate their potential to serve as turn mimics.[2]



References

1. McDonald, I. M. *et al*. *J*. *Med*. *Chem*. **2006**, *49*, 2253-2261.
2. Douchez A., Lubell W. D. *Org*. *Lett*. **2015**, *17*, 6046-6049.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO16 – Transition Metal Catalyzed Direct *Ortho*-Aroylation of Arene C–H Bonds Through Aerobic Oxidative Coupling Reaction

Bhavin V. Pipaliya and Asit K. Chakraborti*

Department of Medicinal Chemistry, National Institute of Pharmaceutical Education and Research (NIPER), Sector 67, S. A. S. Nagar 160 062, Punjab, India

e-mail: bhavinpipaliya@gmail.com

Friedel-Crafts acylation of arenes is the most accepted strategy for diaryl ketone synthesis but it requires the corrosive Lewis acid $AlCl_3$. Arene pre-functionalization and organometallic reagents synthesis limits the use of metal-catalyzed carbonylative coupling. During the last few years, aroylation of arenes through direct C–H bond functionalization by transition metal complexes have been widely utilized in organic synthesis. A novel strategy for direct *ortho*-aroylation of arene C–H bonds by transition metal catalyst has been devised using organocatalytic dioxygen activation. This catalytic method provides new access to the synthesis of aryl ketones guided by suitably positioned directing groups. The practicability of the catalytic efficacy of this protocol was established by synthesis of bioactive molecule using C–H aroylation as crucial step. The present work provides a green and practical method to synthesize diarylketones which are important structural motifs in the pharmaceuticals, fragrance, dye, and agrochemicals as well.

WITHDRAWN

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

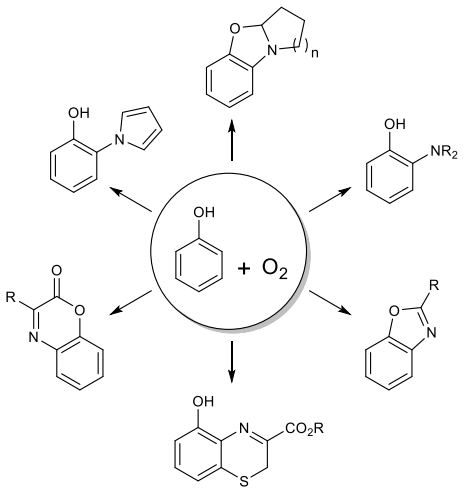
PO17 – A General Platform for the Synthesis of 1,2-Oxy-Amino Arenes by a Bio-Inspired Coupling of Phenols and Amines

Kenneth Virgel N. Esguerra, Wenbo Xu, Jean-Philip Lumb*

Department of Chemistry, McGill University, Montréal (Québec), Canada H2A 0B8

E-mail: jean-philip.lumb@mcgill.ca

1,2-Oxy-amino arenes, including 1,2-amino-phenols, are widely distributed in pharmaceuticals, natural products and electronic materials. The structural diversity encompassed by this core motif typically requires a specialized synthetic methodology for each target that generally elaborates an *ortho*-aminophenol. Although cross-coupling reactions between halogenated arenes with nitrogen or oxygen nucleophiles have been reported, these methodologies require pre-functionalized starting materials, forcing reaction conditions, and reaction optimization for a given heteroatom nucleophile. In contrast, biological processes rely on simple and facile condensation of amines and carbonyls to generate aromatic carbon-nitrogen bonds, a process that is exemplified in various *ortho*-quinone mediated deamination reactions catalyzed by quinoproteins. In an effort to harness this mode of reactivity, we have developed a bio-inspired synthesis of 1,2-oxy-amino arenes that hinges on an copper-catalyzed aerobic oxygenation of phenols to *ortho*-quinones, followed by fragment coupling with a range of amines. The method provides a unified approach for the synthesis of 1,2-oxy-amino arenes of diverse structure, at the sole expense of reducing dioxygen (O_2) to water (H_2O).



Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

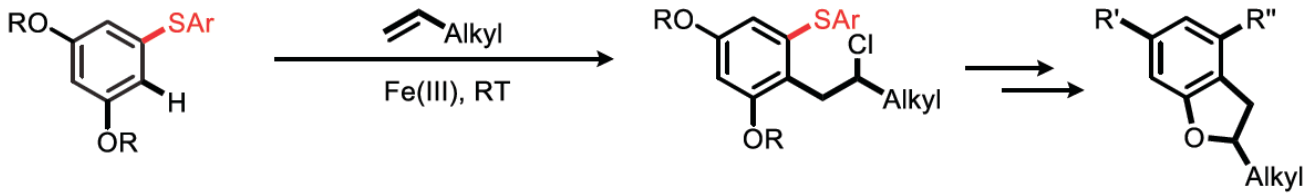
PO18 – Iron-Mediated Oxidative C–H Coupling of Arenes and Alkenes Directed by Sulfur: A Novel Route to Dihydrobenzofurans

Craig W. Cavanagh,[a] Miles H. Aukland,[a] Quentin Laurent,[a] Alan Hennessy[b] and David J. Procter*[a]

[a]*School of Chemistry, University of Manchester, Oxford Road, Manchester, M13 9PL, UK*
[b]*Syngenta, Jealott's Hill International Research Centre, Bracknell, Berkshire, RG42 6EY, UK*

E-mail: david.j.procter@manchester.ac.uk

The use of earth-abundant metals for C–C bond formation is becoming increasingly attractive. Here a sulfur-directed Fe(III)-mediated *ortho* C–H coupling of arenes with unactivated terminal alkenes is reported. This procedure enables regioselective chloroarylation of alkenes and yields versatile products that are amenable to further functionalization. C–H coupling products have been converted to medicinally important dihydrobenzofurans by utilizing a deprotection/heterocyclization cascade and by using the sulfur directing group as a handle for further elaboration.



- Fe(III)-mediated C–H coupling of alkenes and arenes
- direction by sulfur
- short route to benzofurans

References

1. Zhou, L.; Lu, W. *Chem. Eur. J.* **2014**, *20*, 634.
2. Liu, C.; Yuan, J.; Gao, M.; Tang, S.; Li, W.; Shi, R.; Lei, A. *Chem. Rev.* **2015**, *115*, 12138.
3. Cavanagh, C. W.; Aukland, M. H.; Hennessy A.; Procter D. J. *Chem. Commun.* **2015**, *51*, 9272.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO19 – Computational Mechanistic Study of Rhodium-Catalyzed C–H Amination Reactions Using *N*-Mesyloxycarbamates

Emna Azek, Matthias Ernzerhof* and Hélène Lebel

Department of Chemistry, Faculty of Arts and Sciences, Université de Montréal, P.O. Box 6128, Station Downtown, Montréal, QC, Canada H3C 3J7

E-mail: matthias.ernzerhof@umontreal.ca

Transition metal-catalyzed C–H amination reactions via metal nitrenes species is an interesting synthetic approach to prepare nitrogen-containing molecules.[1,2] Although many synthetic applications of these reactions have been developped, there are only a few detailled mechanistic study available.[3,4] Furthermore, none of them has been performed using *N*-sulfonyloxycarbamates an alternative amination reagents to iminoiodinanes.[5,6] In this context, a computational mechanistic study of catalytic amination reactions using tetrakiscarboxylate rhodium dimers as catalysts and *N*-sulfonyloxycarbamates as metal nitrenes precursors has been initiated by the Density Functional Theory (DFT). The surface of potential energy of insertion reactions of rhodium-nitrenes species into C–H bonds has been examined. Experimental and kinetic studies suggested various reactions paths. In this study, some mechanistic hypotheses have been elucidated, while other reactions key parameters were highlighted.

References

1. Collet, F.; Dodd, R. H.; Dauban, P. *Chemical Communications* **2009**, 5061.
2. Collet, F.; Lescot, C.; Dauban, P. *Chem. Soc. Rev.* **2011**, *40*, 1926.
3. Lin, X. F.; Zhao, C. Y.; Che, C. M.; Ke, Z. F.; Phillips, D. L. *Chem. Asian J.* **2007**, *2*, 1101.
4. Zhang, X.; Ke, Z.; DeYonker, N. J.; Xu, H.; Li, Z.-F.; Xu, X.; Zhang, X.; Su, C.-Y.; Phillips, D. L.; Zhao, C. *J. Org. Chem.* **2013**, *78*, 12460.
5. Lebel, H.; Huard, K.; Lectard, S. *J. Am. Chem. Soc.* **2005**, *127*, 14198.
6. Huard, K.; Lebel, H. *Chem. Eur. J.* **2008**, *14*, 6222.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

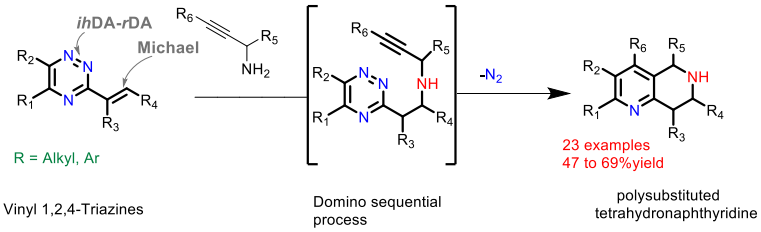
PO20 – One-Pot Synthesis of Polysubstituted Tetrahydronaphthyridines via Michael Addition and Inverse Electron Demand Diels−Alder Reaction

Jabrane Jouha,[a,b] Mostapha Khouil,[b] Jean-François Brière,[c] Gérald Guillaumet,[a] Franck Suzenet*[a]

[a] *Université d'Orléans, CNRS, ICOA, UMR 7311, 45067 Orléans, France*
[b] *Université Sultan Moulay Slimane - Faculté des Sciences et Techniques, BP 523, 23000 Beni-Mellal, Maroc*
[c] *Normandie Université, COBRA, UMR 6014 et FR 3038; Univ Rouen, INSA Rouen; CNRS, IRCOF, 1 rue Tesnière, 76821 Mont Saint-Aignan cedex, France*

E-mail: jabranejouha@gmail.com

A general approach has been developed for the one-pot synthesis of polysubstituted tetrahydronaphthyridines from 3-vinyl-1,2,4-triazine platforms used as unprecedented Michael acceptors. This sequence provides a novel access to functionalized [1,6]-fused tetrahydronaphthyridine derivatives via a unique amine promoted intramolecular *ih*DA reaction. This approach allows the variation not only of the substituent on the aromatic core and on the amine moiety, but also the size of the nonaromatic ring.



References

1. Lorion, M.; Guillaumet, G.; Brière, J.F.; Suzenet, F. *Org. Lett.* **2015**, *17*, 3154.
2. Badarau, E.; Suzenet, F; Finaru, A.L. ; Guillaumet, G. *Eur. J. Org. Chem.* **2009**, *21*, 3619.
3. Jouha, J; Brière, J.F.; Guillaumet, G.; Suzenet, F. *Org. Lett.* Submitted.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

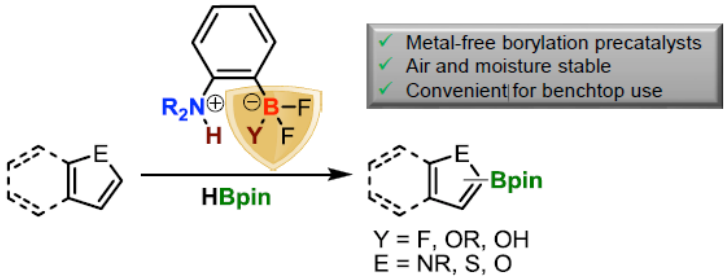
PO21 – Recent Development in the Metal-Free Catalytic Csp^2-H Bond Activation and Borylation by Frustrated Lewis Pairs

Etienne Rochette, Nicolas Bouchard, Julien Légaré Lavergne, Marc-André Légaré and Frédéric-Georges Fontaine*

Département de chimie and Centre de recherche en Catalyse et Chimie Vert (C3V), Université Laval, 1045 Avenue de la Médecine, Québec, QC, G1V 0A6, Canada

E-mail: frederic.fontaine@chm.ulaval.ca

Frustrated Lewis pairs (FLPs) are well known for their ability to activate small molecules, notably hydrogen,[1] which leads to their use in catalytic metal-free hydrogenation.[2] Recently, our research group extended the use of FLPs to include the activation and borylation of Csp^2–H.[3] The recent developments concerning the synthesis and catalytic activity of bench stable pre-catalysts[4] and towards the design and the synthesis of more active catalysts will be dicussed.



References

1. Welch, G.C.; San Juan, R.; Masuda, J.D.; Stephan, D.W. *Science* **2006,** *314,* 1124-1126.
2. Stephan, D. W.; Erker, G. FLP chemistry: *Topics in Current Chemistry*; Eds.; Springer: New York, 2013; Vols, 332, and 334.
3. Légaré, M.-A.; Courtemanche, M.-A.; Rochette, É.; Fontaine, F.-G. *Science* **2015**, *349*, 513-516.
4. Légaré, M.-A.; Rochette, É.; Lavergne, J. L.; Bouchard, N.; Fontaine, F.-G. *Chem. Commun.* **2016**, *52*, 5387-5390

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

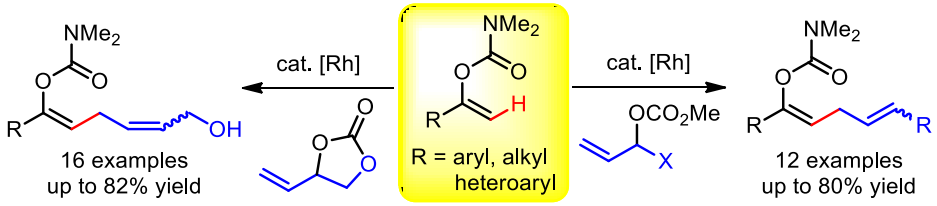
PO22 – Rh(III)-Catalyzed Allylation of Enol Carbamates with Allylic Carbonates

Satyasheel Sharma, Sangil Han and In Su Kim*

School of Pharmacy, Sungkyunkwan University, Suwon 440-746, Republic of Korea

E-mail: insukim@skku.edu

With the development of catalytic C–H bond functionalization, a great deal of effort has been devoted to the catalytic functionalization of vinylic C–H bonds such as simple alkenes, acrylates, vinylic imines, acrylamides, enamides, and enolates.[1] However, the catalytic C–H functionalization of enol carbamates has been rarely exploited, and only two literatures were presented for the Rh(III)-catalyzed C–H olefination of enol carbamates with allenes and acrylates.[2] Our continued efforts on the rhodium-catalyzed C–H allylation reactions of aromatic compounds prompted us to explore the reaction of enol carbamates with allylic carbonates. Herein, we described the rhodium(III)-catalyzed direct C–H allylation of enol carbamates with 4-vinyl-1,3-dioxolan-2-one and allylic carbonates, affording allylic alcohols and terminal allylated products, respectively.



References

1. (a)Chen, Z.; Wang, B.; Zhang, J.; Yu, W.; Liu, Z.; Zhang, Y. *Org. Chem. Front.* **2015**, *2*, 1107. (b) Shang, X.; Liu, Z.-Q. *Chem. Soc. Rev*. **2013**, *42*, 3253.
2. (a) Gong, T.-J.; Su, W.; Liu, Z.-J.; Cheng, W.-M.; Xiao, B.; Fu, Y. *Org. Lett.* **2014**, *16*, 330. (b) Boultadakis-Arapinis, M.; Hopkinson, M. N.; Glorius, F. *Org. Lett.* **2014**, *16*, 1630.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO23 – Metal-Catalysed *trans*-Carbometallative Cyclizations of Alkynyl Electrophiles

Connor Yap, Christopher Clarke, Celia Incerti-Pradillos, Gabriel Lenagh-Snow and Prof. Hon Wai Lam*

School of Chemistry, The University of Nottingham, University Park, NG7 2RD, United Kingdom

E-mail: hon.lam@nottingham.ac.uk

A general approach has been developed for the tandem cyclisations of alkynyl tethered electrophiles. Carbometallative cyclisations of alkynes traditionally proceed in a *cis* manner, followed by nucleophilic attack onto a tethered proximal electrophile. However, we have recently developed a novel catalytic system based on an abundant base metal which participates in a formal *trans* addition, thereby leading to products which are inaccessable by conventional means. Asymmetric variants lead to highly enantioenriched products, and the unique reactivity of this system provides a cost effective and complimentary method to existing carbometallative cascade reactions.

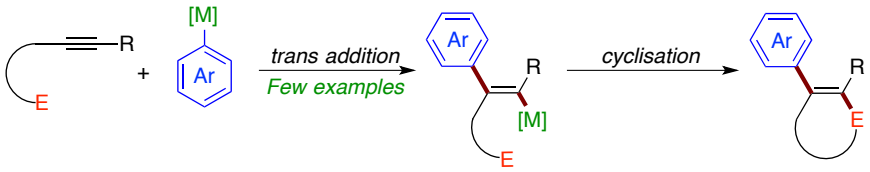


Figure 1: *trans*-carbometallations of alkynes.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

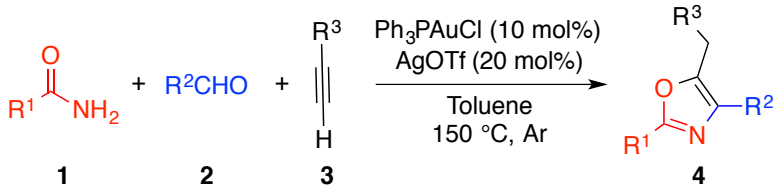
PO24 – Gold Catalyzed Tandem Reactions of Amide-Aldehyde-Alkyne Coupling and Cyclization Synthesis of 2,4,5-Trisubstituted Oxazoles

Pierre Querard, Simon A. Girard, Nick Uhlig and Chao-Jun Li*

Department of Chemistry, and FQRNT Centre for Green Chemistry and Catalysis, McGill University, 801 Sherbrooke Street West, Montreal, QC H3A 0B8, Canada

E-mail: cj.li@mcgill.ca

With the widespread use and demand of simple methodologies for the synthesis of complex molecules in medical and industrial applications, it is increasingly important to develop ingenuous synthetic pathways allowing the ease access of molecular complexity. By furnishing complex products from simple building blocks in a minimum of steps, multicomponent reactions represent efficient and rapid alternatives to traditional stepwise syntheses. We report the first cationic gold(I)-catalyzed one-pot reaction of amide, aldehyde and alkyne followed by cyclization, to successfully access highly substituted oxazoles derivatives in good yields. Oxazoles are important heterocyclic motifs present in a wide range of bioactive molecules, natural products, advanced materials, and ligand frameworks. They exhibit highly variable properties and their structures are extremely diverse. Our development of this new catalyzed one-pot reaction of amide, aldehyde and alkyne followed by cyclization demonstrated that catalyzed tandem reactions could be extended towards many other synthetically useful motifs.



1 2 3 4

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

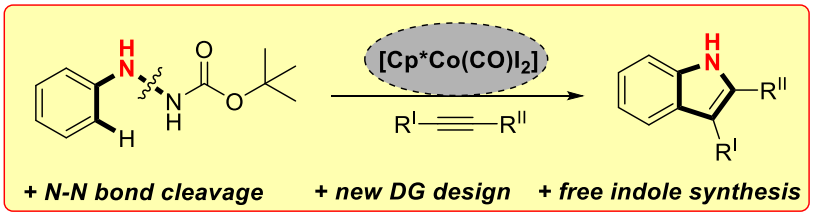
PO25 – Cobalt(III)-Catalyzed Redox-Neutral Synthesis of Unprotected Indoles Featuring an N–N Bond Cleavage

Andreas Lerchen, Suhelen Vasquéz-Céspedes, and Frank Glorius*

Department of Organic Chemistry, Universität Münster, Corrensstraße 40, 48149 Münster, Germany

E-mail: glorius@uni-muenster.de

In 2013 Kanai and Matsunaga developed several Cp*Co(III) catalysts, which are complementary and comparable to the conventional catalyst systems of Cp*Rh(III) and Cp*Ir(III) that prompted various groups to join this research area.[1] The Cp*Co(III) chemistry is so far restricted to a handfull of different directing groups as well as to a few transformations. Therefore, we wanted to focuss our research on i) the development of an unprecedented Cp*Co(III)-catalyzed indole synthesis and on ii) the development of a new redox-neutral directing group.[2] As a part of our research interest[3] we were able to showcase a redox-neutral Cp*Co(III)-catalyzed synthetic approach for the direct synthesis of unprotected indoles featuring an N–N bond cleavage. The herein newly introduced Boc-protected hydrazines establish a beneficial addition to the limited portfolio of internal oxidizing directing groups for Cp*Co(III)-catalysis. Moreover, the developed catalytic methodology tolerates a variety of functional groups and offers an efficient complement to conventional catalyst systems.[4]



References

1. Review on Co-catalysis: M. Moselage, J. Li, L. Ackermann, *ACS Catal.* **2016**, *6*, 498.
2. Review on Indole-synthesis: N. Yoshikai, Y. Wei, *Asian J. Org. Chem.* **2013**, *2*, 466.
3. Cp*Co(III) research from Glorius *et al.*: D.-G. Yu, T. Gensch, F. de Azambuja, S. Vásquez-Céspedes, F. Glorius, *J. Am. Chem. Soc.* **2014**, *136*, 17722; D. Zhao, J. H. Kim, L. Stegemann, C. A. Strassert, F. Glorius, *Angew. Chem. Int. Ed.* **2015**, *54*, 4508; *Angew. Chem.* **2015**, *127,* 4591; T. Gensch, S. Vásquez-Céspedes, D.-G. Yu, F. Glorius, *Org. Lett.* **2015**, *17*, 3714; Q. Lu, S. Vásquez-Céspedes, T. Gensch, F. Glorius, *ACS Catal.* **2016**, *6*, 2352; J. H. Kim, S. Greßies, F.Glorius, *Angew. Chem. Int. Ed.* **2016**, DOI: 10.1002/anie.201601003.
4. This work: A. Lerchen, S. Vásquez-Céspedes, F. Glorius, *Angew. Chem. Int. Ed.* **2016**, *55*, 3208; *Angew. Chem.* **2016**, *128*, 3261.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO26 – A Directed *ortho* Metalation Approach to Unusually Substituted Indazole Heterocycles

John Fu Cullen, and Victor Snieckus*

Department of Chemistry, Queen's University, Kingston, ON K7L 3N6, Canada

E-mail: queensu7212@gmail.com

This research project is concerned with developing new methodology for the synthesis of unusually substituted indazole heterocycles (Fig. 1). Specifically, the synthesis of 7-substituted indazoles will be pursued based on recent preliminary results in the Snieckus laboratories. The interest in these systems is derived from their medicinal and pharmacological properties, which include anti-inflammatory, anti-HIV, anti-depressant, antimicrobial, anticancer, antiprotozoal, antihypertensive, hypoglycemic, contraceptive and other activities. Access to such substituted indazoles is achieved only with difficulty by electrophilic aromatic substitution (S_NAr) and other classical reactions. A literature review provides the following different synthetic pathways towards the production of substituted indazoles: cyclization of *o*-methylbenzenediazonium salts, *N*-(2 nitrobenzylideneamines), *o*-methyl-*N*-nitrosoanilines, and *o*-acyl-arylhydrazines, hydrazones of *o*-acylbenzenes, and [3+2]-cycloaddition reaction of lithium trimethylsilyldiazomethane with benzynes. The [3+2]-cycloaddition pathway is the only reaction that has produced 4- and 7-methyl, methoxy, amino substituted indazoles using halobenzenes and $TMSC(Li)N_2$ (lithium trimethylsilyldiazomethane) starting materials. Our approach involves attempt to effect the directed ortho metalation (DoM) reaction on C-3 protected indazoles bearing an *N*-directed metalation group (DMG) (Fig. 2) to obtain the C-7 deprotonated species which by quench reactions with various electrophiles would lead to 7-substituted indazoles and thereby allow the development of a new general route to these derivatives.

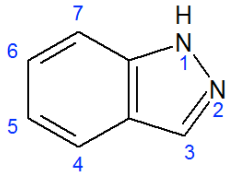


Figure 1. 1H-indazole

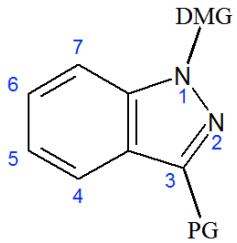


Figure 2. PG = Cl, TMS, DMG = $CONEt_2$

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

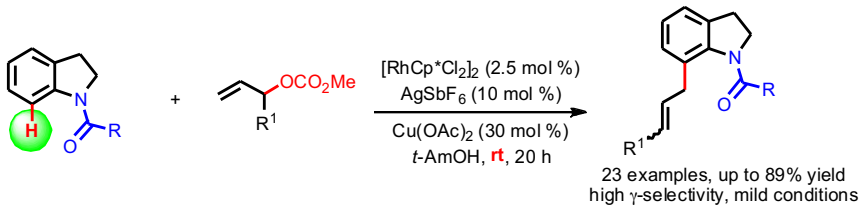
PO27 – C7-Allylation of Indolines with Allylic Carbonates Under Rhodium Catalysis

Jihye Park*

School of Pharmacy, Sungkyunkwan University, Suwon 440-746, Republic of Korea

E-mail: qkr3548@naver.com

The indoles and indolines are ubiquitous structural motifs found in a large number of natural products with diverse and important biological activities.[1] In particular, the allylated indole or indoline alkaloids are widely distributed in terrestrial and marine organisms, especially in the genera Penicillium and Aspergillus of ascomycota, and display broad structural diversity.[2] Notably, the C7-allylated indoles and indolines are known as pivotal heterocyclic compounds found in a number of bioactive synthetic molecules and natural products.[3] Herein, we described the rhodium-catalyzed direct allylation and crotylation of indolines with allylic carbonates via C–H bond activation.[4]



References

1. (a) Joule, J. A. Mills, K. Heterocyclic Chemistry; *Blackwell Science Ltd.: Oxford*, **2000**. (b) Boger, D. L. Boyce, C. W. Garbaccio, R. M. Goldberg, *J. A. Chem. Rev*. **1997**, 97, 787.
2. Li, S.-M. *Nat. Prod. Rep*. **2010**, 27, 57.
3. (a) Chakravarty, S. Hart, B. P. Jain, R. P. WO 2011103460 A1, 2011. (b) Kreft, A. F. Caufield, C. E. Failli, A. A. Caggiano, T. J. Greenfield, A. A. Kubrak, D. M. US 5776967 A, 19984.
4. Park, J. Mishra, N. K. Sharma, S. Han, S. Shin, Y. Jeong, T. Oh, J. S. Kwak, J. H. Jung, Y. H. Kim, I. S. *J. Org. Chem*. **2015**, 80, 1818.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

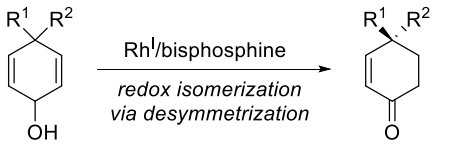
PO28 – Rhodium-Catalyzed Desymmetrative Redox Isomerization of Cyclohexa-2,5-Dienols

Thomas Johnson, Steffen Kress, and Mark Lautens*

Department of Chemistry, University of Toronto, 80 St. George St, Toronto, ON M5S 3H6, Canada

E-mail: mlautens@chem.utoronto.ca

The catalytic redox isomerization of allylic alcohols into saturated carbonyl compounds is one of the earliest metal-catalyzed reaction to have been studied. Despite notable advances over the years, little attention has been paid to this reaction in the field of complex molecule synthesis. In this context, we have developed a new redox isomerization for the synthesis of γ,γ-disubstituted cyclohexenones, which are useful intermediates in total synthesis. The functional group tolerance of the reaction compares favorably with that of classical redox isomerizations. The synthetic and mechanistic aspects of the reaction as well as the characteristics of the enantioselective version will be presented.



15 examples
up to 95% yield

R^1, R^2 contains ester, amide, ether, carbamate, etc.

Reference

1. Kress, S.; Johnson, T.†; Lautens, M. *ACS Catal.* **2016**, *6*, 747.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

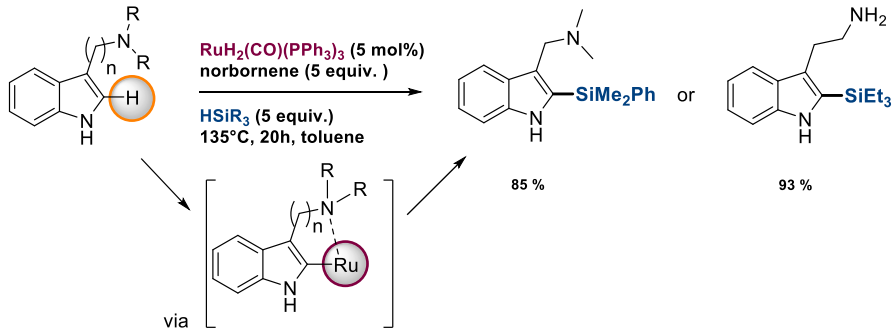
PO29 – Ruthenium Catalyzed C–H Silylation of Unprotected Gramines, Tryptamines and Their Congeners

Carina Sollert,[a] Karthik Devaraj,[a] C. Juds,[a] Paul J. Gates,[b] Lukasz T. Pilarski*[a]

[a] Department of Chemistry-BMC, Uppsala University, Box 576, SE-75123, Uppsala, Sweden
[b] School of Chemistry, University of Bristol, Cantock's Close, Bristol, BS8 1TS, UK

E-mail: lukasz.pilarski@kemi.uu.se

Much attention has been paid to the development of efficient procedures to functionalize indoles containing substrates due to their ubiquitous presence in many natural products and biologically active compounds. Silyl substituents have been introduced into indoles via the addition of aryl magnesium or aryl lithium reagents to silicon electrophiles or by transition metal catalysed C–H functionalization. Recent work on the C(2)–H selective silylaltion of indole substrates has been explored using rhodium[1], iridium[2] and Kt-OBu_3 catalysis. However, that methodology is not applicable to unprotected naturally-occurring compounds such as gramine and tryptamine. We have developed the selective C(2)–H silylation of gramine and related compounds employing an electron rich ruthenium (Ru^0) catalyst using exocyclic nitrogen as a directing group, demonstrating a straight forward strategy to access silylated biologically relevant heteroarenes. The method can be applied to (benzo)thiophenes and –furans as well as pyrrole and unprotected indoles. Insights into the reaction mechanism have been obtained with the help of deuterium labelling experiments.



Scheme 1: Ruthenium catalysed C(2)-H silylation of gramine and tryptamine.

References

1. Cheng, C.; Hartwig, J. F. *Science*, **2014**, *343*, 853.
2. a) Lu, B.; Falck, J. R. *Angew. Chem. Int. Ed.* **2008**, *47*, 7508; b) Hua, Y.; Jung, S.; Roh, J.; Jeon, J. *J. Org. Chem.*, **2015**, *80*, 4661; c) Ishiyama, T.; Sato, K.; Nishio, Y.; Saiki, T.; Miyaura, N. *Chem. Commun.*, **2005**, 5065; d) Murai, M.; Takami, K.; Takeshima, H.; Takai, K. *Org. Lett.*, **2015**, *17*, 1798.
3. Toutov, A. A.; Liu, W.-B.; Betz, K. N.; Fedorov, A.; Stoltz, B. M.; Grubbs, R. H. *Nature*, **2015**, *518*, 80.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

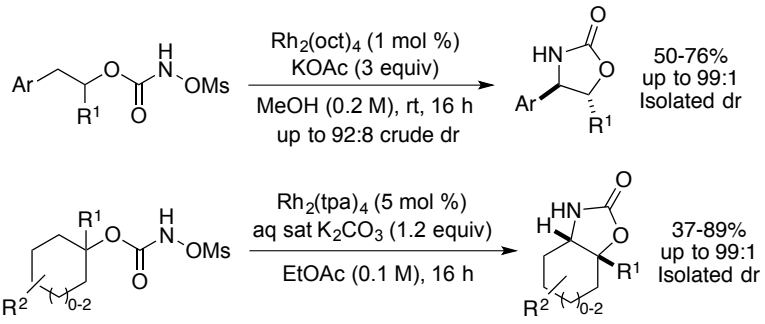
PO30 – Rhodium-Catalyzed Intramolecular C–H Amination: Synthesis of Chiral Oxazolidinones from *N*-Mesyloxycarbamates

Maroua Khalifa and Hélène Lebel*

Department of Chemistry, Faculty of Arts and Sciences, Université de Montréal, P.O. Box 6128, Station Downtown, Montréal, QC H3C 3J7, Canada

E-mail: helene.lebel@umontreal.ca

Oxazolidinones are important biologically active heterocycles which can be found in a variety of synthetic pharmaceutical compounds.[1] Our research group has reported *N*-sulfonyloxycarbamates as metal nitrene precursors that can undergo intramolecular C–H amination affording oxazolidinones in good yields.[2,3] By decreasing the molecular weight of the reagent and the catalyst loading, while using non-chlorinated solvents, a novel green procedure was recently developed using *N*-mesyloxycarbamates and a rhodium (II) dimer catalyst. The methodology was extended *N*-mesyloxycarbamates derived from secondary and tertiary alcohols. Good to excellent diastereostereoselectivities were obtained affording a variety of chiral highly subtituted oxazolidinones. These synthetic results will be presented as well as control experiments to establish the mechanism of the reaction.



References

1. Michalska, K.; Karpiuk, I.; Król, M.; Tyski, S. *Bioorg. Med. Chem.* **2013**, *21*, 577.
2. Lebel, H.; Huard, K.; Lectard, S. *J. Am. Chem. Soc.* **2005**, *127*, 14198.
3. Huard, K.; Lebel, H. *Chem. Eur. J.* **2008**, *14*, 6222.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

PO31 – Harnessing the Power of C–H Functionalization in Drug Discovery

Sriram Tyagarajan,[a*] Sobhana B. Boga,[a] L.C. Campeau,[b] Timothy A. Cernak,[a] Renee K. Dermenjian,[c] Daniel DiRocco,[b] George Doss,[e] Spencer D. Dreher,[b] Kevin D. Dykstra,[a] Roy Helmy,[c] Shane W.Krska,[a] Ravi Kurukulasuriya[d], Yong Liu[c], Milana M. Maletic,[a] Keith P. Moore,[a] Craig Parish,[a] Mikhail Reibarkh,[e] Eric Streckfuss,[a] Petr Vachal,[a] R. Thomas Williamson,[e] and Haifang Yao[c]

Departments of Automation & Capabilities Enhancement,[a] Catalysis & Automation,[b] Project Analytical Chemistry,[c] LO Chemistry,[d] NMR Structure Elucidation,[e] Merck Research Laboratories, Merck & Co., Inc., Rahway, NJ, USA.

E-mail: sriram_tyagarajan@merck.com

In the last several years, there has been an exponential growth in literature related to the field of C–H functionalization. Harnessing the power of these emerging chemistries promises to enable medicinal chemists to make modifications at the very last step of a synthesis or in advanced intermediates, thus providing access to sites which were previously unexplored or underexplored. This presentation will describe a variety of high-value C–H functionalization chemistry platforms developed at Merck and in collaboration with academic laboratories and give examples of how these technologies have been deployed successfully for efficient diversification of medicinally important scaffolds in the drug discovery space.

Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

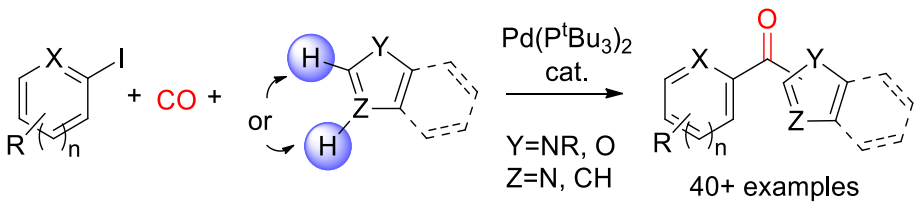
PO32 – An Electrophilic Approach to the Palladium-Catalyzed Carbonylative C–H Functionalization of Heterocycles

Jevgenijs Tjutrins and Bruce A. Arndtsen*

Department of Chemistry, McGill University, 801 Sherbrooke Street West, Montreal, QC H3A 0B8, Canada

E-mail: Bruce.Arndtsen@mcgill.ca

The palladium catalyzed C–H functionalization of arenes and heteroarenes has become an important approach in synthetic chemistry for the synthesis of wide range of bulding blocks, pharmaceutical scaffolds, and polymers. In contrast to classical cross coupling methodologies, the direct functionalization of C–H bonds does not require stoichiometric organometallic reagents and/or pre-activated compounds, which potentially could lead to greater efficiency, atom economy, and minimizes the generation of byproducts. While many transition metal catalyzed C–H arylation, alkylation, alkynylation, alkenylation reactions of arenes and heteroarenes have been developed, transition metal catalyzed carbonylative C–H functionalizations have not been extensively studied, presumably due to the inhibitory effect of C–O on C–H activation. Herein a novel palladium catalyzed approach to intermolecular carbonylative C–H functionalization will be described. This transformation is mediated by Pt-Bu_3-coordinated palladium catalyst, and allows the derivatization of a diverse range of heterocycles, such as pyrroles, indoles, imidazoles, benzoxazoles and furans. Preliminary studies suggest that this reaction proceeds via the catalytic formation of highly electrophilic acid iodide intermediates. Overall, this provides a novel atom economical route to generate aryl-(hetero)aryl ketones using bench stable reagents.



Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

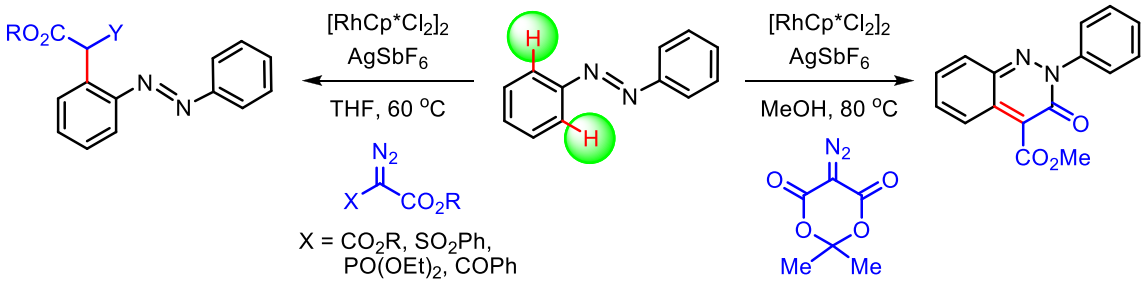
PO33 – Synthesis of Cinnolin-3(2*H*)-ones with Azobenzenes and α-Diazo Esters under Rhodium Catalysis

Sang Hoon Han*

School of Pharmacy, Sungkyunkwan University, Suwon 440-746, Republic of Korea

E-mail: sang0306@nate.com

N-Containing heteroaromatics are important substructures found in numerous natural or synthetic organic molecules. The diversity of the structures encountered, as well as their biological and pharmaceutical relevance, have motivated research aimed at the development of new economical, efficient and selective synthetic strategies to access these compounds. In particular, transition metal-catalyzed direct functionalization of C–H bonds is one of the key emerging strategies that are currently attracting tremendous attention with the aim to provide alternative environmentally friendly and efficient ways for the construction of heterocycles. Cinnolin-3(2*H*)-ones are known to be a key structure of biologically important azaheterocyclic scaffolds. Thus, the establishment of robust synthetic approaches for affording substituted cinnolin-3(2*H*)-one from easily available compounds is highly desirable. In continuation of our recent studies on the rhodium-catalyzed C–H functionalization for the construction of heteroaromatics and their functionalizations, we herein present the Rh(III)-catalyzed direct formation of substituted cinnolin-3(2*H*)-ones using azobenzenes and α-diazo compounds.



Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

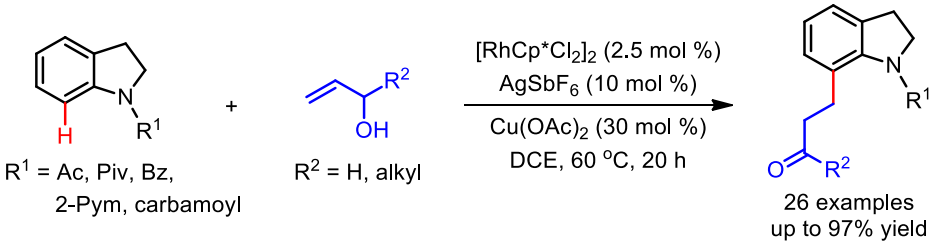
PO34 – Direct Access to β-Aryl Carbonyl Compounds using Indolines and Allylic Alcohols via Rh(III)-Catalyzed C–H Alkylation

Sang Hoon Han*

School of Pharmacy, Sungkyunkwan University, Suwon 440-746, Republic of Korea

E-mail: sang0306@nate.com

The β-aryl ketones are among the versatile synthetic precursors in organic and medicinal chemsitry, and are important structural motifs found in a range of bioactive natural products and pharmaceuticals. The well-known methods for the preparation of β-aryl ketones are oxidative Heck reaction between aryl nucleophiles and allylic alcohols, 1,4-addition reaction of stoichiometric organozinc reagents with enones, and chemoselective reduction of β-aryl unsaturated ketones. The direct C–H alkylation of arenes with allylic alcohols for the formation of β-aryl ketones and aldehydes, despite its critical importance, has been rarely realized. Allylic alcohols have long served as versatile substrates for the construction of carbon frameworks due to their commerical availability, low cost, easy preparation and handling. Notably, allylic alcohols have been used as the chemical equivalent of α,β-unsaturated ketones and aldehydes in most of the catalytic reactions. we herein present the Rh(III)-catalyzed direct C–H alkylation of indolines, carbazoles and pyrroles with various allylic alcohols, affording the corresponding β-aryl carbonyl compounds.



Université de Montréal, Montréal, QC, Canada

THIRD INTERNATIONAL SYMPOSIUM
ON C–H ACTIVATION

May 30 – June 2, 2016

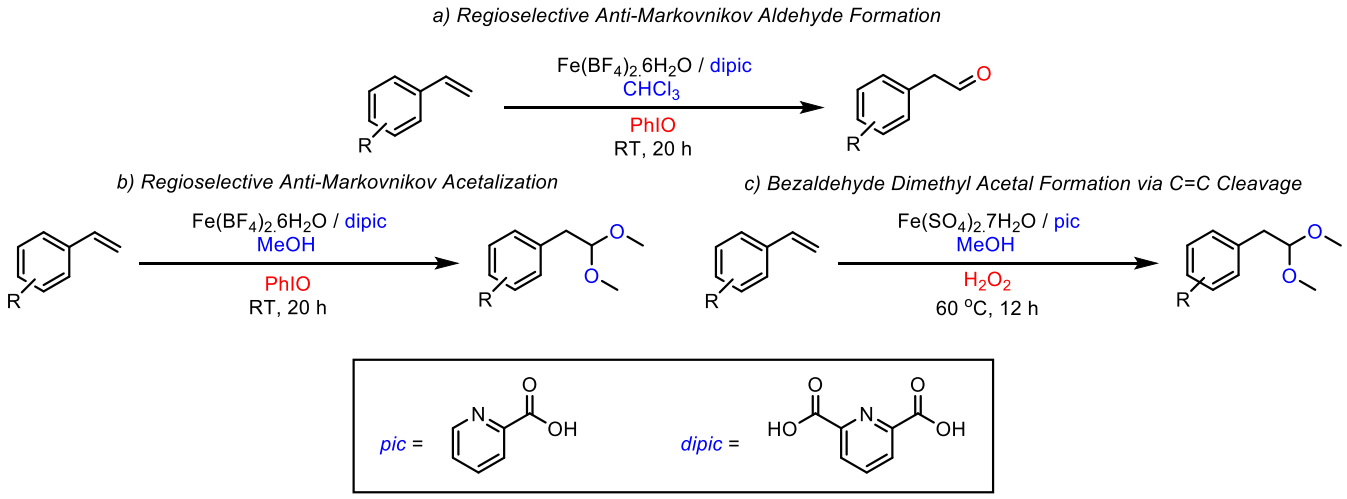
PO35 – Efficient Iron Catalyzed Anti-Markonikov Oxidation of Terminal Olefins

Ritwika Ray, Abhishek Dutta Chowdhury and Goutam Kumar Lahiri*

Department of Chemistry, Indian Institute of Technology Bombay, Powai, Mumbai- 400076, India

E-mail: ritwika@chem.iitb.ac.in; lahiri@chem.iitb.ac.in

Regioselective olefin functionalization has gained significant emphasis in recent decades. Among them, Wacker type oxidation of terminal olefins with anti-Markovnikov selectivity remains one of the most challenging tasks. In this regard, an efficient iron catalyzed system has been developed for the conversion of alkenes to aldehydes with reversed Wacker selectivity (Scheme **1a**). A similar approach has been instrumental towards the formation of anti-Markovnikov acetals (Scheme **1b**) from terminal olefins, and interestingly, a direct transformation of styrene to bezaldehyde dimethyl acetal with C=C cleavage was achieved using H_2O_2 as the oxidant (Scheme **1c**). Further, mechanistic studies emphasizes the crucial role of solvent and denticity of ligands in guiding the product distribution profile.



Scheme 1. An Outline for Iron Catalyzed Anti-Markovnikov Oxidation of Terminal Olefins

References

1. Chowdhury, A. D.; Ray, R.; Lahiri, G. K. *Chem. Commum.* **2012**, *48*, 5497.
2. Chowdhury, A. D.; Lahiri, G. K. *Chem. Commum.* **2012**, *48*, 3448.
3. Ray, R.; Chowdhury, A. D.; Abhishek, D.; Lahiri, G. K. *ChemCatChem* **2013**, *5*, 2158.