

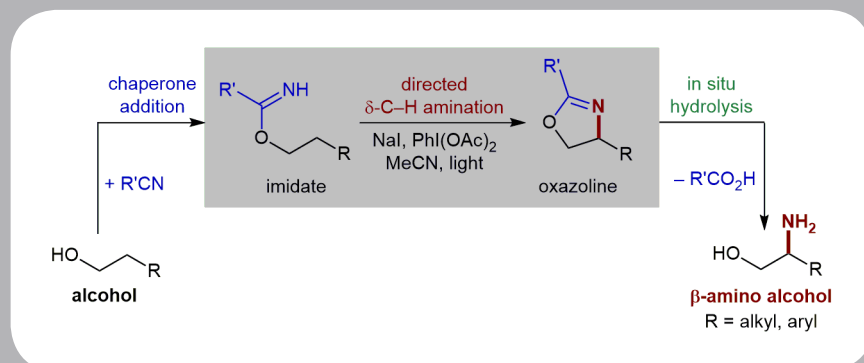
# Synform

People, Trends and Views in Chemical Synthesis

2018/01

## Directed $\beta$ -C-H Amination of Alcohols via Radical Relay Chaperones

Highlighted article by E. A. Wappes, K. M. Nakafuku, D. A. Nagib



### Contact

Your opinion about Synform is welcome,  
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## Dear Readers,

Welcome to the first SYNFORM issue of 2018! This is a rather heterogeneous issue, featuring three different types of articles. Notably, there are two Editorial Board Focus Interviews with new SYNLETT Editorial Board Members who are joining the Thieme Chemistry family: Professor Rubén Martín from ICIQ (Spain) and Professor David A. Nicewicz from the University of North Carolina at Chapel Hill (USA). Welcome to the new Editors and please read their interviews to know more about their interests and research. Perhaps you will make a more personal acquaintance with them soon when you submit your next manuscript to SYNLETT! We also have a Young Career Profile interview with Professor J.-W. Lee (Denmark) who shares with us his thoughts about organic chemistry and research achievements in his career so far. The two ‘classical’ articles cover different aspects of the synthesis of nitrogen-containing compounds. Professor D. A. Nagib (USA) and his  $\beta$ -amination of alcohols using a novel radical chemistry strategy is the protagonist of the first contribution, while Professor X. Liao (P. R. of China) and his ingenious synthesis of N-unsubstituted imines from alkyl azides is the focus of the second one.

And that’s all for January 2018!

Enjoy your reading!



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If you have any questions or wish to send feedback, please write to Matteo Zanda at: [synform@outlook.com](mailto:synform@outlook.com)

## Directed $\beta$ -C–H Amination of Alcohols via Radical Relay Chaperones

*J. Am. Chem. Soc.* **2017**, *139*, 10204–10207

The 1,2-hydroxyamino unit is ubiquitous in natural compounds and pharmacologically active molecules, thus representing a major synthetic target in organic chemistry. Although a number of syntheses of  $\beta$ -amino alcohols are available, chemists still devote considerable efforts towards developing novel strategies for improving atom economy, expanding the scope and maximizing the environmental sustainability of the methods for producing this key structural unit.

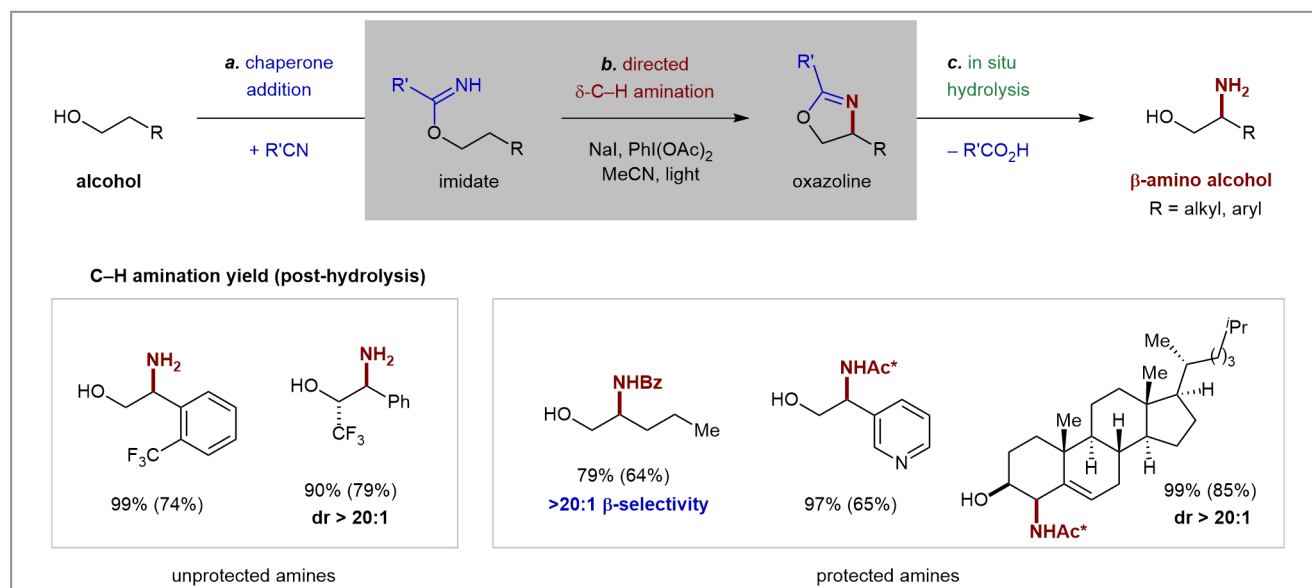
Recently, a new paper describing an innovative radical-mediated approach that enables the  $\beta$ -C–H amination of alcohols, which represents the first example of the ‘radical relay chaperone’ concept, was published by the group of Professor David A. Nagib at The Ohio State University (Columbus, USA). Professor Nagib explained: “Simple, traceless tethers (e.g. imidates) can be appended to ubiquitous functional motifs – such as hydroxyl groups – to enable directed C–H functionalization of a wide range of molecules, including drugs and bioactive compounds. As a proof-of-principle, we have developed a new and efficient method for the synthesis of  $\beta$ -amino alcohols via the regioselective C–H amination of alcohols.”

“Previously, the elegant work from the lab of Professor Du Bois (Stanford University, USA) represented the best approach for  $\beta$ -C–H amination of an alcohol derivative (i.e. carbamate),”

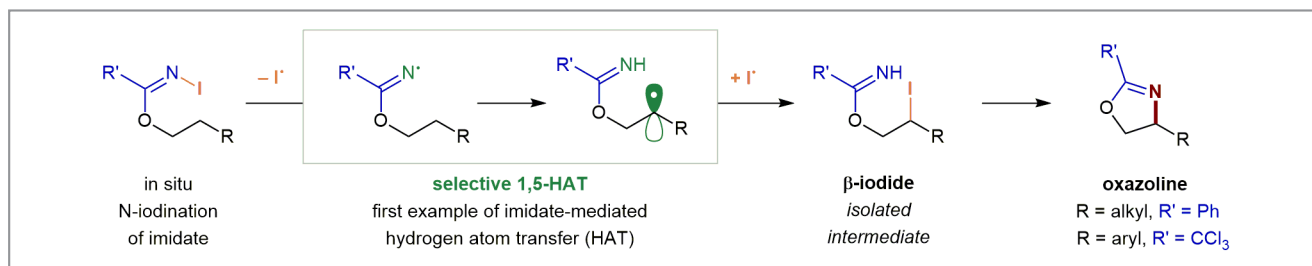
said Professor Nagib (for references see the original *JACS* article). “In a similar vein, Professors He (The University of Chicago, USA) and Lebel (University of Montréal, Canada) have reported the only other examples of this reaction, also employing Rh or Ag nitrenoids. Interestingly, for many years following these initial reports, further developments in nitrene-based C–H amination chemistry had been predominantly in the area of  $\gamma$ -C–H amination – as demonstrated, for example, by the important recent contributions of the Wisconsin-based group of Professor Schomaker – leaving an unmet need in the area of vicinal,  $\beta$ -amino alcohol synthesis,” added Professor Nagib.

“Our radical-mediated strategy offers synthetic complementarity relative to the use of metal-nitrenes, and also offers the advantage of a broadened scope, which includes the possibility of using a range of unbiased aliphatic alcohols, as well as secondary alcohols,” explained Professor Nagib. He continued: “In this paper we included examples of many different classes of alcohols, showcasing a wide range of functional group tolerance that is an important feature of our new radical-mediated approach.”

“Importantly, we have developed a one-pot protocol in which an alcohol is rapidly converted into its  $\beta$ -amino analogue via in situ conversion into imidates, directed C–H amination,



**Scheme 1** Radical relay chaperone strategy for  $\beta$ -C–H amination of alcohols (Ac\* = COCl<sub>3</sub>)



**Scheme 2** Mechanism of triiodide-mediated C–H amination

and hydrolysis to NH<sub>2</sub> group,” remarked Professor Nagib. “And we think it’s pretty cool that this entire process (alcohol to  $\beta$ -amino alcohol) is completed in a single afternoon!”

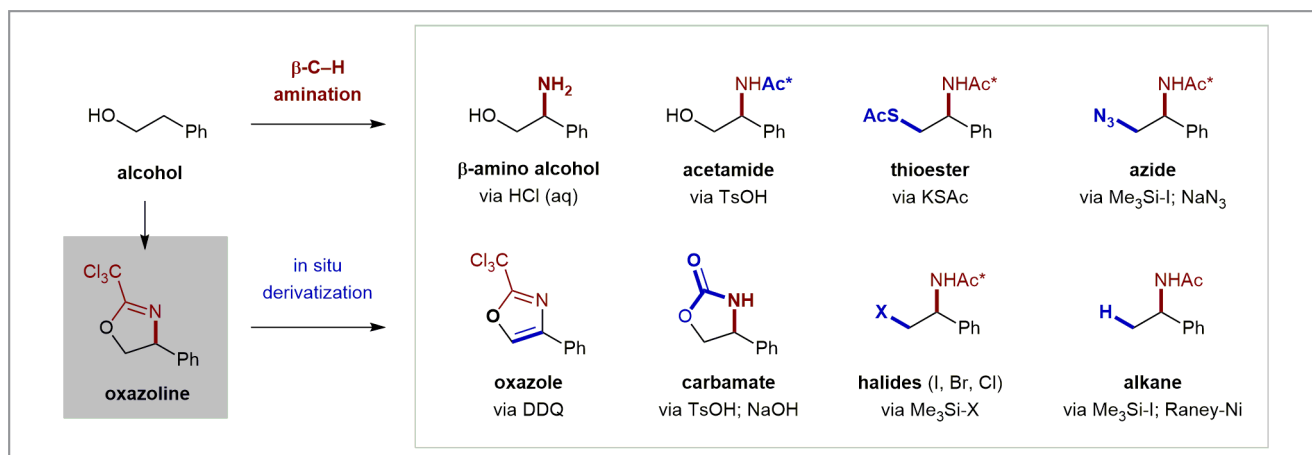
Professor Nagib revealed that after tirelessly searching for two years to find the right chaperone (and observing many radical-mediated decomposition mechanisms along the way), the group knew that they had achieved a major breakthrough as soon as they tested the imidate-based scaffold, since this chaperone gave quantitative C–H amination at the first try. Professor Nagib joked: “Ethan and Kohki prefer basketball, but they were certainly dancing plenty that day!”

The trichloroimidates that the group employed in this chemistry are quite popular synthetic intermediates thanks to the Overman rearrangement. “Interestingly, in a great biographical perspective, Professor Overman describes the serendipitous discovery of his eponymous rearrangement while he was actually trying to discover a method to convert allylic alcohols into  $\beta$ -amino alcohols, but instead recovered allyl amines,” said Professor Nagib, who added with a smile: “We are grateful that Overman’s lab was distracted by their beautiful chemistry, allowing us to discover this C–H amination approach to access that original target.”

The group borrowed the term ‘chaperone’ from the field of biology, where it describes a protein that helps to direct the folding of other proteins. “Similarly, we thought this name provided a perfect way to describe our idea that a traceless promoter could interact with a molecule via a common motif (an alcohol in this case), initiate a radical cascade, and then be removed to leave behind a molecule with significantly more value than its precursor,” explained Professor Nagib.

The group performed mechanistic experiments to shed insight into the underpinnings of this process, which is the first example of a 1,5-hydrogen atom transfer (HAT) initiated by an imidate radical. “Our experiments indicate that the HAT event is rate-limiting with kinetic isotope effect values up to 8. Stereochemical experiments also differentiate this radical mechanism from the nitrenoid pathway,” said Professor Nagib. He continued: “For example, in this  $\beta$ -C–H amination, the stereochemistry is defined by the intramolecular substitution event. Knowledge of this mechanism has enabled us to develop a second-generation chaperone that promotes C–H amination of unbiased, aliphatic alcohols.”

The broad impact, significance, and synthetic utility of this chaperone strategy has been demonstrated via  $\beta$ -amination



**Scheme 3** Access to a family of C–H aminated products via in situ derivatization (Ac\* = COCCl<sub>3</sub>)

of a wide range of alcohols containing unbiased C–H bonds, tolerating a wide range of biologically relevant functionality (e.g. ethers, esters, amines, organofluorine compounds). “Notably, the oxazoline intermediate can also be further derivatized to a family of  $\beta$ -amines, which have never been previously prepared from alcohols in this manner,” said Professor Nagib.

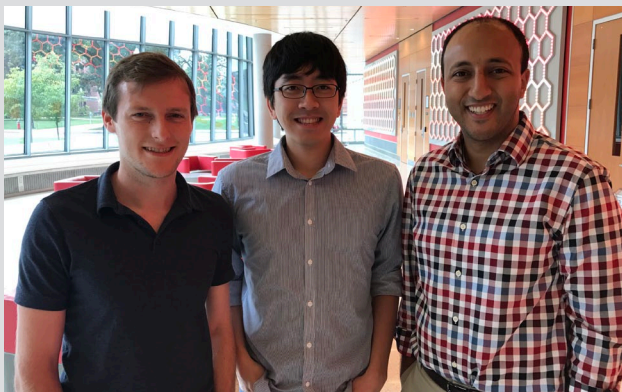
“We anticipate that due to the widespread presence of  $\beta$ -amino alcohols in highly valuable molecules (e.g. pharmaceuticals, natural products, and catalysts), this chemistry will be employed widely,” said Professor Nagib. He continued: “Furthermore, we expect that our lab and others’ (in both the burgeoning areas of radical chemistry and C–H functionalization) will be able to expand this strategy to develop other useful C–H functionalization reactions.”

Concerning future potential applications of the method, Professor Nagib remarked: “While presenting these findings at a recent conference, we were excited by the strong interest we heard from medicinal chemists in industry, who are interested in employing this strategy for the diversification of molecules in their drug-candidate libraries.”

He concluded: “Amines are ubiquitous in pharmaceuticals, agrochemicals, and ligand architectures; therefore, we hope that both the academic and industrial communities will take advantage of this new approach to rapidly synthesize  $\beta$ -amino alcohols directly from simple feedstock alcohols. We envisage that the simplicity, mildness, efficiency, and low cost of reagents featured by this strategy will enable a widespread use of radical relay chaperones for a number of synthetic applications.”

*Matthew Farnok*

### About the authors



From left: E. Wappes, K. Nakafuku, Prof. D. Nagib

**Ethan Wappes** (Fort Wayne, IN, USA) earned a B.Sc. with honors at Indiana University (USA) in 2014, where he studied electrochemical ring expansions with Professor Dennis Peters. At The Ohio State University (OSU, USA), he is a co-founder of the Nagib Lab, where he has pioneered triiodide-mediated C–H aminations, and he has been awarded an OSU Charles Waring Fellowship. He has also earned honorable mention from the National Science Foundation (NSF) Graduate Research Fellowship program, as well as a travel award from the American Chemical Society (ACS) Division of Organic Chemistry.

**Kohki Nakafuku** (Loveland, OH, USA) earned a B.Sc. with honors at Duke University (USA) in 2014, where he studied the kinetics and mechanism of gold-catalyzed allene racemization with

Professor Ross Widenhoefer. At OSU (USA), he is a co-founder of the Nagib Lab, where he has pioneered the development of new synthetic reactions via a radical relay chaperone strategy.

**David Nagib** (Philadelphia, PA, USA) earned a B.Sc. with honors at Boston College (USA) in 2006, where he studied alcohol desymmetrization via small enzyme-like catalysts with Professor Scott Miller. At Princeton University (PhD, 2011), he developed new trifluoromethylation reactions via photoredox catalysis with Professor David MacMillan. As an NIH Postdoctoral Scholar at the University of California, Berkeley (USA), David studied C–H activation via oxidative gold mechanisms with Professor F. Dean Toste, and catalysis within metal-organic framework materials with Professor Omar Yaghi. Since 2014, David has been an Assistant Professor in the Department of Chemistry and Biochemistry at The Ohio State University (USA), where his team’s research on radical-mediated C–H functionalization has been recognized by the American Chemical Society (PRF, 2015), National Institutes of Health (MIRA, 2016), National Science Foundation (CAREER, 2017), and the Thieme Chemistry Journals Award (2017). David was a finalist for the OSU Distinguished Undergraduate Research Mentor Award (2016), and has recently become a proud father.

Outside the lab, Ethan, Kohki, and David enjoy running local races that have beer, burgers, and brats at the finish line (but never paint-throwing!). Their other hobbies include watching college basketball, drawing hieroglyphs on papyrus, and enjoying great food, art, and music at Columbus’ many summer festivals.

## Editorial Board Focus: Professor Rubén Martín (Institute of Chemical Research of Catalonia (ICIQ), Spain)

**Background and Purpose.** From time to time, SYNFORM portraits Thieme Chemistry Editorial Board or Editorial Advisory Board members who answer several questions regarding their research interests and revealing their impressions and views on the developments in organic chemistry as a general research field. This Editorial Board Focus presents Professor Rubén Martín (Institute of Chemical Research of Catalonia (ICIQ), Spain) who joins the Editorial Board of SYNLETT with effect of January 1, 2018 as a new member.

### Biographical Sketch



Prof. R. Martín

**Rubén Martín** received his PhD in 2003 from the University of Barcelona (Spain) under the supervision of Professor Antoni Riera. He moved in 2004 to the Max-Planck Institut für Kohlenforschung (MPI, Germany) as a Humboldt Postdoctoral Fellow, working with Professor Alois Fürstner and then in 2005 to the Massachusetts Institute of Technology (MIT, USA) as a Postdoctoral Fellow working with Professor Stephen L. Buchwald. In 2008, he moved back to Spain and was appointed as Assistant Professor at the Institute of Chemical Research of Catalonia (ICIQ), and since 2013 he has held the position of Catalan Institution of Research and Advanced Studies (ICREA) Research Professor in the same institution.

He has received several awards since beginning his independent research career: in 2008, he received the Ramon y Cajal Award and in 2010 the Sigma Aldrich RSEQ Young Research Investigator Award. In 2011, he received both the Thieme Chemistry Journals Award and the Eli Lilly Young Research Investigator Award. He was awarded the RSEQ Excellent Research Award in 2015, and two further awards in 2017: the Marcial Moreno Lectureship Award and the OM-COS Award. In 2018, he will undertake duties as a Genetech Lecturer, Pharmaron Lecturer and Bristol-Meyers Squibb Lecturer.

### INTERVIEW

**SYNFORM** *What do you think about the modern role and prospects of organic synthesis?*

**Prof. R. Martín** As chemists, we should be providing creative solutions to challenging problems while making them look easy.

**SYNFORM** *Let us know more about your research activities in general and what the focus of your group's current research is?*

**Prof. R. Martín** Our research is focused on the discovery of synthetically useful organometallic methodologies, with a particular emphasis on the implementation of earth-abundant nickel catalysts for the functionalization of particularly strong sigma bonds. In particular, we have designed new nickel-catalyzed reductive carboxylation techniques of organic matter with abundant and inexpensive carbon dioxide as C1 synthon, representing a straightforward route for preparing carboxylic acids from simple precursors under mild conditions and in a user-friendly manner. Our group has also designed new nickel-catalyzed transformations via the activation of strong C–O bonds, contributing to the prolific use of simple phenol derivatives as organic halide surrogates, while providing new vistas from a both methodological and mechanistic standpoint.

**SYNFORM** *What is your most important scientific achievement to date and why?*

**Prof. R. Martín** Beyond any reasonable doubt, to find balance between my work and my family, and to make my students love the projects as much as I do while seeing them

mature through the years. From a scientific standpoint, our most important scientific achievements have been on the ability to promote C–C bond-forming reactions via catalytic fixation of CO<sub>2</sub> into organic matter en route to carboxylic acids as well as the design of catalytic technologies for functionalizing strong sigma C–O bonds derived from simple phenol derivatives.

Handwritten signature in orange ink that reads "Matteo Fagnola".

## Editorial Board Focus: Professor David A. Nicewicz (University of North Carolina at Chapel Hill, USA)

**Background and Purpose.** From time to time, SYNFORM portraits Thieme Chemistry Editorial Board or Editorial Advisory Board members who answer several questions regarding their research interests and revealing their impressions and views on the developments in organic chemistry as a general research field. This Editorial Board Focus presents Professor David A. Nicewicz (University of North Carolina at Chapel Hill, USA) who joins the Editorial Board of SYNLETT with effect of January 1, 2018 as a new member.

### Biographical Sketch



Prof. D. A. Nicewicz

**Dave Nicewicz** was born and raised in the United States in Central New Jersey, before moving to North Carolina, where he completed his Bachelor's (2000) and Master's (2001) degrees in Chemistry at the University of North Carolina (USA) at Charlotte with Professor Craig A. Ogle. He then moved to the University of North Carolina at Chapel Hill (USA) where he completed his Ph.D. with Professor Jeffrey S. Johnson. Dave's studies were focused on the development of acyl anion equivalents generated via 1,2-Brook rearrangements from silylglyoxylates, which he was able to successfully apply to a total synthesis of zaragozic acid C to complete his Ph.D. in 2006. Following his graduate education, Nicewicz moved back to his native New Jersey in 2007, where he was a Ruth L. Kirschstein Postdoctoral Fellow in the laboratories of Professor David W. C. MacMillan. It was during this time that Nicewicz pioneered the use of ruthenium photoredox catalysis in combination with chiral amine organocatalysis to develop a general method for enantioselective aldehyde alkylation. In July of 2009, Dave went on to begin his independent career at the University of North Carolina at Chapel Hill, where his laboratory has focused on organic photoredox catalysis for the development of novel chemical reactivity. He has received a number of awards early on in his career from the University of North Carolina (James Moeser Award for Distinguished Research; Ruth Hettleman Prize for Artistic and Scholarly Achievement), industry (Boehringer Ingelheim New Investigator Award in Organic Chemistry; Amgen Young Investigator Award; Eli Lilly Grantee Award), private foundations (Packard Fellowship in Science and Engineering; Camille

Dreyfus Teacher-Scholar Award) as well as international recognition (Society of Synthetic Organic Chemistry, Japan Lectureship Award; The 13<sup>th</sup> Hirata Award, Nagoya University). In 2015, he was promoted to the rank of Associate Professor, where he leads a research group focused on organic methodology development, catalysis and complex molecule synthesis.

### INTERVIEW

**SYNFORM** Please comment on your new role as a Member of the Synlett Editorial Board!

**Prof. D. A. Nicewicz** I am excited to be a part of the SYNLETT Editorial Board and to have the opportunity to view the newest science before it hits the press. In addition to my excitement in joining an excellent Editorial Board steered by Ben List, I am also happy to hear that Rubén Martín will also be joining me on the SYNLETT team – I believe this will create a great mix of young and established scientists that will no doubt strengthen the journal. In this regard, I am eager to learn more and contribute to new ways to improve the submission and review process. As a specific example, it is encouraging to see that SYNLETT is breaking new ground in the latter area with Intelligent Crowd Review, which I believe could be the future of peer review.

**SYNFORM** What do you think about the modern role and prospects of organic synthesis?

**Prof. D. A. Nicewicz** Organic synthesis in the 21<sup>st</sup> century has to focus on sustainability. There is almost nothing that synthetic organic chemists can't make and so our goal



moving forward should be designing new catalytic processes that avoid the use of toxic or expensive reagents, make use of abundant and renewable chemical feedstocks and design new materials that have a minimal impact on our environment. For these reasons, I truly believe there are a multitude of new opportunities for catalysis, methods development and polymer chemistry that can be applied and at the same time, are scientifically stimulating.

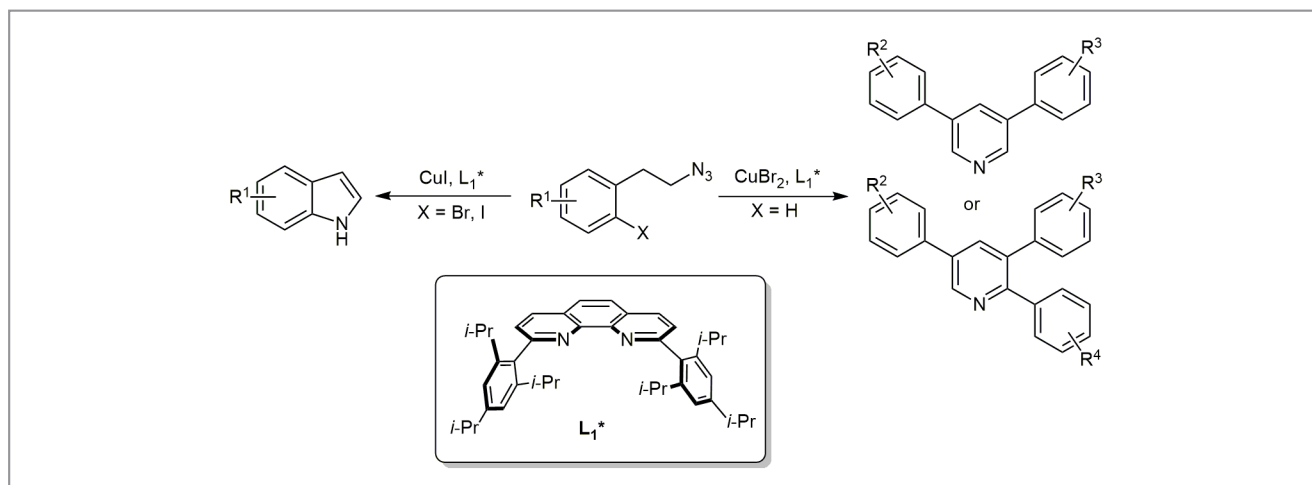
**SYNFORM** *Please let us know more about your research activities in general and what the focus of your group's current research is?*

**Prof. D. A. Nicewicz** My laboratory's goals, from a broad prospective, are to develop new enabling technologies that speak to the themes mentioned in my previous comment: design new catalytic processes that minimize waste and environmental impact by introducing scientifically-stimulating concepts. To this end, my laboratory is focused on the use of simple visible-light-absorbing organic dyes that catalyze organic transformations via single electron transfer processes. We have employed organic photoredox catalysis for alkene anti-Markovnikov hydrofunctionalization reactions, molecular rearrangements, arene and alkane C–H functionalization and recently, methods for catalysis of classical reactivity such as the Newman–Kwart rearrangement and nucleophilic aromatic substitution of aromatics. Currently, we are applying some of this methodology to the total synthesis of naturally-occurring molecules as well as medicinal agents.



# In Situ Generation of N-Unsubstituted Imines from Alkyl Azides and Their Applications for Imine Transfer via Copper Catalysis

*Sci. Adv.* 2017, DOI: 10.1126/sciadv.1700826



**Scheme 1** Novel methodology to synthesize multi-substituted pyridines or indole derivatives

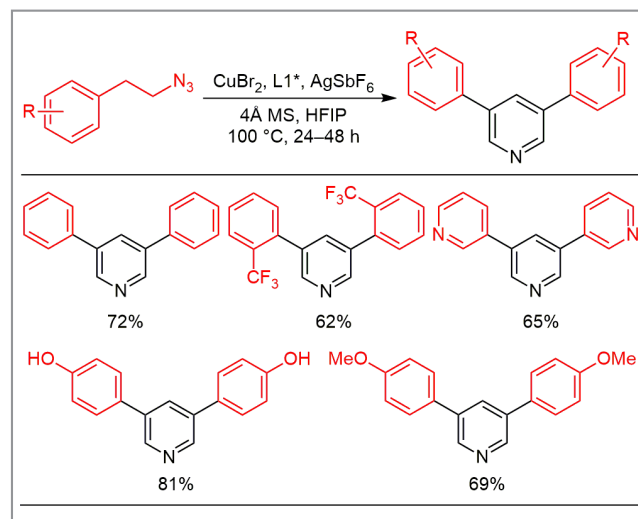
N-Unsubstituted aliphatic imines have rarely been used in synthetic organic chemistry since this chemistry is affected by several drawbacks, especially the necessity of pre-forming protected imines and subsequently removing the N-protecting group. To solve this problem, the group of Professor Xuebin Liao at Tsinghua University (Beijing, P. R. of China) developed a method to produce in situ N–H imines generated from alkyl azides. In addition, they also explored the reactivity of aliphatic N–H imines and their application in the unusual construction of multi-substituted pyridines or indole derivatives (Scheme 1).

“It is believed that alkyl azides could be ideal precursors for in situ generation of N–H imines, because of their notable features such as: (i) facile accessibility and (ii) environmental friendliness (in fact they only release an equivalent of nitrogen as byproduct),” explained Professor Liao. He continued: “Inspired by the seminal work of Albertin, Park, and Rhee, among others (see the original article for references), we strived to develop a method to produce N–H imines using an earth-abundant copper catalyst. With the in situ generated N–H imine methodology, we have successfully constructed multi-substituted pyridines (Scheme 2) and indoles.”

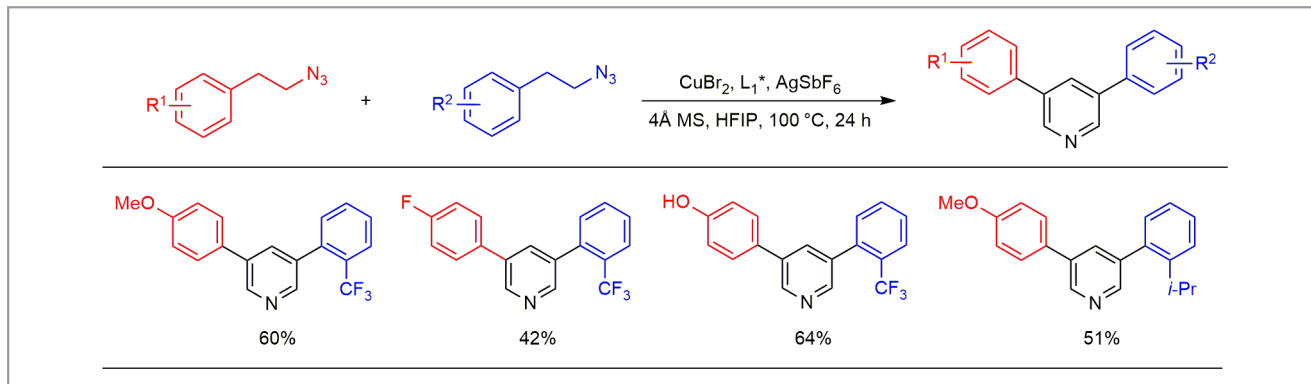
Besides that, the group was also pleased to discover that either unsymmetrical 3,5-diaryl pyridines (Scheme 3) or

2,3,5-triaryl pyridines (Scheme 4) could be obtained using this method.

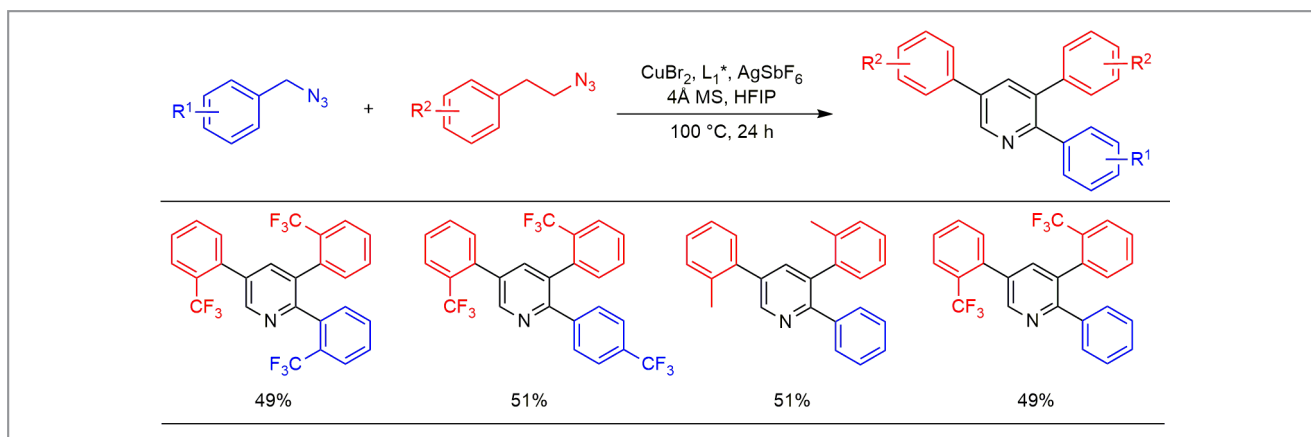
“To the best of our knowledge, this is the first reported transformation of alkyl azides into multi-substituted pyridines or N–H indoles (Scheme 5),” remarked Professor Liao.



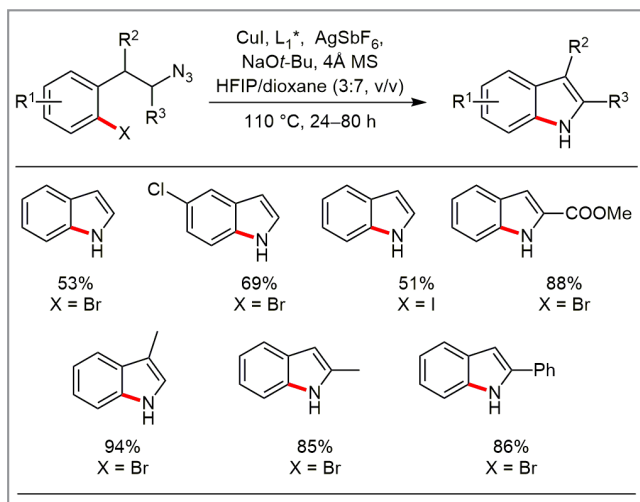
**Scheme 2** Construction of 3,5-diaryl pyridines



Scheme 3 Construction of unsymmetrical 3,5-diaryl pyridines



Scheme 4 Construction of 2,3,5-triaryl pyridines



Scheme 5 Construction of indoles

“We believe our chemistry has a lot of potential for further strengthening the role of imine chemistry and will be widely applied by the synthetic community. This work was completed by a junior student in my group, Lu Hu, and I very much appreciate his hard work and dedication.”

“Further work is still ongoing in our laboratory,” concluded Professor Liao. “Firstly, we are continuing to develop other potential applications of imine chemistry. Our attention will mainly focus on exploring chiral catalysis for the application of N–H imines on their downstream transformations. Secondly, we will investigate the details of the mechanism involved in this transformation, through which we hope to achieve chemoselective catalytic transformations of azides to engage them in either nitrene transfer or imine chemistry.”

*Lu Hu*

## About the authors



L. Hu

**Lu Hu** was born in 1991 in Wuhan (P. R. of China). He received his B.S. degree in Chinese medicine from the Huazhong University of Science and Technology (P. R. of China) in 2014. Afterwards, he joined Professor Liao's group at the School of Pharmaceutical Sciences, Tsinghua University (P. R. of China) as a graduate student. His main research interests include the development of new synthetic reactions using late-transition-metal catalysts and natural product synthesis.



Dr. Y. A. Liu

He has co-authored 68 publications and serves on two biochemistry journal editorial boards. His main research interests

**Yahu A. Liu** received his PhD degree in organic chemistry from Case Western Reserve University (Canada) under the guidance of late Professor Lawrence M. Sayre in 2000. Afterwards, he worked in medicinal chemistry teams at Pharmacia/Pfizer, Vertex, and ChemBridge. In 2007, he joined the Genomics Institute of Novartis Research Foundation (USA), where he is currently an Investigator III and chemistry outsourcing lead.

include drug discovery, natural product synthesis, synthetic methodology and supramolecular chemistry. He had also served as President of Sino-American Biotechnology and Pharmaceutical Professional Association from 2015 to 2017.



Prof. X. Liao

a position of Research Investigator I at the Genomics Institute of the Novartis Research Foundation (GNF, USA). At GNF, his research was centered on discovering new drug candidates for pharmaceutical optimization. In September of 2012, he joined the Department of Pharmacology and Pharmaceutical Science, School of Medicine, Tsinghua University (P. R. of China). Currently Professor Liao's research focuses on three major areas: 1) bioactive natural product oriented synthesis and new synthetic method development; 2) immuno-oncology projects related to T cell exhaustion and innate immunity; and 3) structure-based drug discovery.

**Xuebin Liao** obtained his B.S. degree from Peking University (P. R. of China) in 1995, and carried out his PhD work on natural product synthesis with Professor James M. Cook at the University of Wisconsin at Milwaukee (USA) from 1998–2004. From 2005–2008, he was a postdoctoral associate with Professor John F. Hartwig at Yale University (USA) and later at the University of Illinois at Urbana-Champaign (USA). In 2009, he held

## Young Career Focus: Professor Ji-Woong Lee (University of Copenhagen, Denmark)

**Background and Purpose.** SYNFORM regularly meets young up-and-coming researchers who are performing exceptionally well in the arena of organic chemistry and related fields of research, in order to introduce them to the readership. This Young Career Focus presents Professor Ji-Woong Lee (University of Copenhagen, Denmark).

### Biographical Sketch



Prof. Ji-Woong Lee

**Ji-Woong Lee** received his BSc and MSc degrees in chemistry from Sungkyunkwan University (Korea) under the guidance of Professor Choong Eui Song (2009). He obtained his PhD under the supervision of Professor Benjamin List at the Max-Planck Institute (Mülheim an der Ruhr, Germany) in 2013. After postdoctoral research stays at the Weizmann Institute of Science (Israel) with Professor Rafal Klajn in 2014 and UC Berkeley (USA) with Jeffrey R. Long in 2016, he is currently an Assistant Professor at the University of Copenhagen (Denmark). He has a string of honors and awards to his name: a Songchun Scholarship, SKKU, Korea (2003–2007); an Army Commendation Medal from his mandatory military service in the Republic of Korea Army, 2nd Infantry Division US Army, where he attained the rank of Sergeant (2006); Dean of Faculty Fellowship, Weizmann Institute of Science, Israel (2014); the Koshland Prize, Weizmann Institute of Science, Israel (2014); Reaxys PhD Prize, Finalist, Switzerland (2014); ITMA Future Material Awards, Finalist, Germany (2014); and a Thieme Chemistry Journals Award (2017).

### INTERVIEW

**SYNFORM** *What is the focus of your current research activity?*

**Prof. J.-W. Lee** My career has been focused on the development of catalytic transformations of small organic molecules, in combination with heterogeneous catalysis, photochemistry and transition-metal catalysis. My independent research interests are largely based on new synthetic strategies in organic synthesis targeting CO<sub>2</sub> functionalization, water-splitting reactions, desalination, and water purification.

**SYNFORM** *When did you get interested in synthesis?*

**Prof. J.-W. Lee** As a kid, I was interested in making things with a small toolbox and doing small experiments. As a teenager, I was crazy about computer games, which require significant brain work. Now I can connect these two through organic synthesis, since synthetic chemists are basically molecular engineers with proper understanding of elements and their reactivity. In undergraduate school I became fascinated by organic chemistry, which was surprisingly easier for me than physical and inorganic chemistry. And many great professors at my school inspired me to dive into organic synthesis. Now I love to draw reaction arrows on the blackboard and think about new crazy reactions.

**SYNFORM** *What do you think about the modern role and prospects of organic synthesis?*

**Prof. J.-W. Lee** Whitesides said “Chemistry is now evolving away from the manipulation of sets of individual molecules and toward the description and manipulation of systems of molecules, that is, living cells and materials” in 1999. It seems that now we are revisiting this idea after last year’s Nobel Prize in Chemistry. As a young enthusiastic organic chemist,

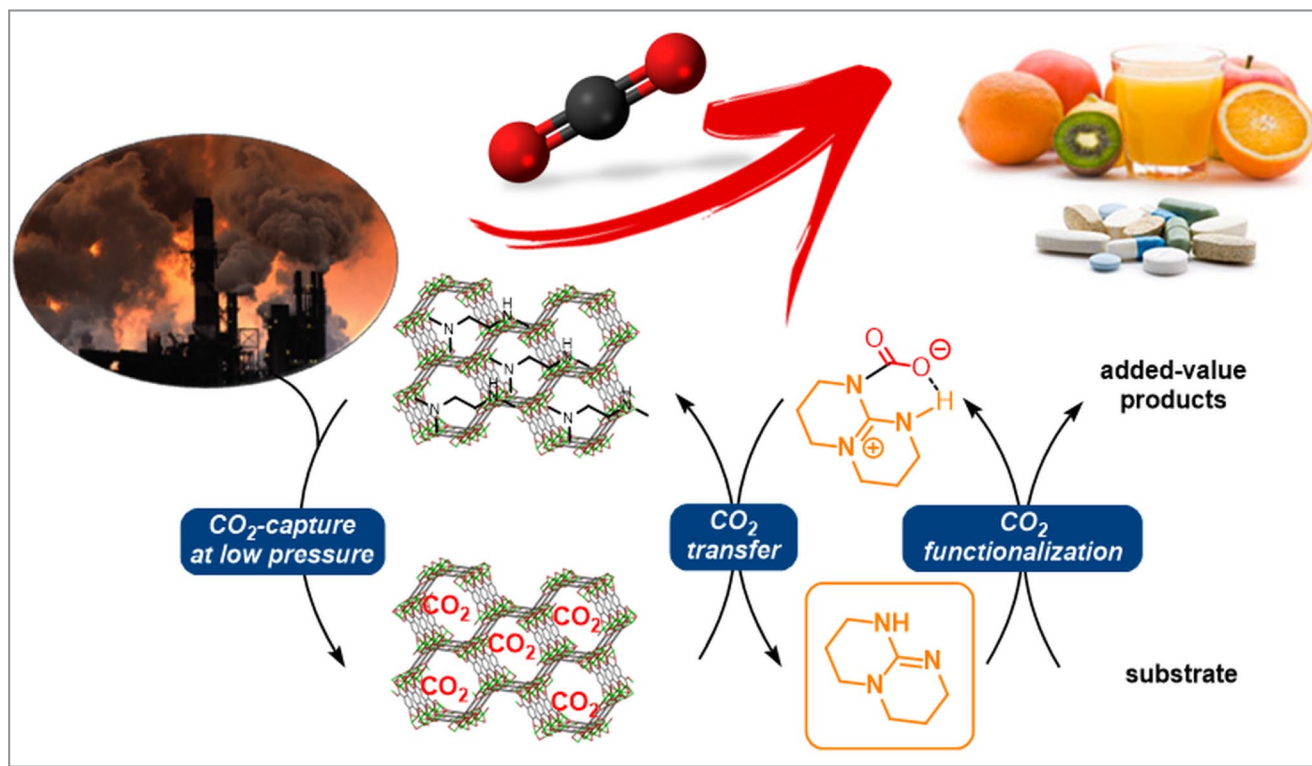


Figure 1

I would say that we have to tackle paramount social issues, such as energy, water and environment, while continuing to pursue a fundamental understanding of organic reactions.

**SYNFORM** Your research group is active in the areas of organic synthesis, catalysis and functional materials. Could you tell us more about your research and its aims?

**Prof. J.-W. Lee** Our group is working on how to use CO<sub>2</sub> more efficiently, while providing added-value products. Due to the high thermodynamic stability of CO<sub>2</sub>, we need to be equipped with selective catalysts for CO<sub>2</sub> activation. Therefore, we are studying how to take CO<sub>2</sub> from the atmosphere and transfer it to the reaction flask more efficiently. Here is where solid-state materials come into play with their high affinity towards CO<sub>2</sub>, where the 'captured' CO<sub>2</sub> molecules can be used for organic transformations. In addition, we are investigating the unusual behavior of CO<sub>2</sub>-responsive materials, for applications in organic synthesis and water purification.

**SYNFORM** What is your most important scientific achievement to date and why?

**Prof. J.-W. Lee** During my PhD studies, I succeeded in developing a new concept of heterogeneous catalysis using textile materials (*Science* **2013**, *341*, 1225) with Professor Benjamin List and collaborators at the Deutsches Textilforschungszentrum. This methodology provides highly reliable, simple, and robust functionalized materials, which can be prepared from inexpensive textiles via one-step modification using light. This allowed us to obtain several catalytic textiles (basic, acidic, chiral, and bifunctional) which showed unprecedented catalytic activity and selectivity in different organic reactions.

*Matthew Farnok*

## Coming soon

— Literature Coverage

### Borate Esters: Simple Catalysts for the Sustainable Synthesis of Complex Amides

— Literature Coverage

### Visible-Light-Promoted C–S Cross-Coupling via Intermolecular Charge Transfer

— Literature Coverage

### Enantioselective Semireduction of Allenes

## Further highlights

### **Synthesis** Review: Recent Advances in Direct C–H Functionalization of Pyrimidines

(by E V. Verbitskiy and co-workers)

### **Synlett** Cluster on “Alkene Halofunctionalization”

(edited by T. Rovis and J. S. Johnston)

### **Synfacts** Synfact of the Month in category “Organo- and Biocatalysis”: Enzymatic Anti-Markovnikov Oxidations of Styrenes

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