

## *Brad P. Carrow*

Assistant Professor of Chemistry  
Curriculum Vitae

Department of Chemistry  
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### PROFESSIONAL EXPERIENCE

- 2013–present **Princeton University** Assistant Professor, Department of Chemistry
- 2011–2013 **University of Tokyo** Assistant Professor, Department of Chemistry and Biotechnology
- 2011 **University of Tokyo** Postdoctoral Fellow, Department of Chemistry and Biotechnology
- 2004 **Brewer Science, Inc.**, Rolla, MO Research Scientist II. Synthesis, deposition, and characterization of new classes of chemical vapor deposition (CVD) polymer thin films and precursors for ultra-low  $\kappa$  interlayer dielectric materials.

### EDUCATION

- 2005–2011 **University of Illinois at Urbana-Champaign** Ph.D., Chemistry  
Ph.D. Advisor: John F. Hartwig  
Studied the synthesis, characterization, and reactivity of intermediates in classic and recently-developed palladium-catalyzed cross-coupling reactions.
- 2003–2004 **Rensselaer Polytechnic Institute**, Troy, NY Visiting Scholar  
Advisors: Toh-Ming Lu and Jay Senkevich  
Studied the synthesis, deposition, and characterization of new classes of chemical vapor deposition (CVD) polymers and precursors.
- 2000–2003 **Missouri University of Science and Technology**, Rolla, MO B.S., Chemistry, Magna Cum Laude, Undergraduate Advisor: Thomas P. Schuman  
Studied the synthesis of silane surface-modifying agents and environmentally-friendly cerium corrosion inhibitors.

### TEACHING

- Spring 2019 Chem 521 “Organometallic Chemistry”
- Spring 2018 Chem 304 “Organic Chemistry II”
- Fall 2017 Chem 532 “Mechanistic & Physical Organic Chemistry”
- Spring 2017 Chem 521 “Organometallic Chemistry”
- Spring 2016 Chem 521 “Organometallic Chemistry”
- Fall 2015 Chem 532 “Mechanistic & Physical Organic Chemistry”
- Spring 2015 Chem 521 “Organometallic Chemistry”

Fall 2014	Chem 532 “Mechanistic & Physical Organic Chemistry”
Spring 2014	Chem 536 “Topics in Organic Chemistry: Organic Chemistry and Catalysis”
Fall 2012	03-770010 “Introductory Lectures in Chemistry and Biotechnology” (Tokyo)
Spring 2012	03-770010 “Introductory Lectures in Chemistry and Biotechnology” (Tokyo)
Spring 2008	Chem 530 “Organic Structure and Spectroscopy” (Teaching Assistant)
Fall 2006	Chem 437 “Organic Chemistry Lab” (Teaching Assistant)
Spring 2006	Chem 437 “Organic Chemistry Lab” (Teaching Assistant)
Fall 2005	Chem 233 “Elementary Organic Chem Lab I” (Teaching Assistant)

## **FUNDING**

NIH NIGMS Maximizing Investigators' Research Award (MIRA) “Aliphatic Effects in Transition Metal Catalysis” (1R35-GM128902)

Princeton Catalysis Initiative “Catalytic Strategies to Enable Next-Generation Recycling in the New Plastics Economy”

NSF CAREER “Enabling Sustainable Polymer Synthesis through Design of New Catalysts” (CHE-1654664)

NSF MRSEC Seed Award (DMR-1420541)

## **Current group members**

Praveen Kilaru (postdoctoral researcher)

Jason Brandt (postdoctoral researcher)

William SiiHong Lau (graduate student)

Daniel Sanchez (graduate student)

Anthony Scavuzzo (graduate student)

Peter Waddell (graduate student)

Long Wang (graduate student)

## **Former postdoctoral researchers**

Jiajun Mei

Peng Ren (associate professor, Harbin Institute of Technology, Shenzhen, China)

Wei Zhang (scientist, Janssen R&D, Spring House, PA)

## **Former graduate student members**

Liye Chen (postdoctoral researcher, University of California Berkeley)

Neil McAlpine

Christian Padilla (ExxonMobil Research and Engineering, Clinton, NJ)

Margaret Tiedemann (ExxonMobil, Baytown, TX)

## **Former Princeton undergraduate student members**

Bradley Gorsline (Seattle Genetics)

Kiwoon Baeg (researcher, Mount Sinai hospital, New York, NY)

Aileen Huang (Columbia Law School, Columbia University)

Cecily O’Leary

## SEMINARS

- 02/05/19 University of Pennsylvania, Philadelphia, PA "Leveraging Electrophilicity and Polarizability in Catalysts for Challenging Coupling Reactions"
- 11/30/2018 University of Chicago, Chicago, IL "Leveraging Polarizability and Electrophilicity in Catalysts for Challenging Coupling Reactions"
- 11/05/2018 Yale University, New Haven, CT "Leveraging Polarizability and Electrophilicity in Catalysts for Challenging Coupling Reactions"
- 10/19/2018 RWTH Aachen University, Aachen, Germany "Leveraging Dispersion and Electrophilicity in Catalysts for Challenging Coupling Reactions"
- 10/18/2018 Münster University, Münster, Germany "Leveraging Dispersion and Electrophilicity in Catalysts for Challenging Coupling Reactions"
- 10/16/2018 Max-Planck-Institut für Kohlenforschung "Leveraging Dispersion and Electrophilicity in Catalysts for Challenging Coupling Reactions"
- 10/15/2018 University of Cologne, Cologne, Germany "Leveraging Dispersion and Electrophilicity in Catalysts for Challenging Coupling Reactions"
- 10/12/2018 University of Bristol, Bristol, England "Leveraging Dispersion and Electrophilicity in Catalysts for Challenging Coupling Reactions"
- 10/11/2018 University of Oxford, Oxford, England "Leveraging Dispersion and Electrophilicity in Catalysts for Challenging Coupling Reactions"
- 10/10/2018 University of Cambridge, Cambridge, England "Leveraging Dispersion and Electrophilicity in Catalysts for Challenging Coupling Reactions"
- 10/08/2018 University of Edinburgh, Edinburgh, Scotland "Leveraging Dispersion and Electrophilicity in Catalysts for Challenging Coupling Reactions"
- 10/01/2018 Indiana University, Bloomington, IN "Mechanism-Driven Catalyst Design for Sustainable Coupling Chemistry"
- 09/25/2018 Seton Hall University, Seton Hall, NJ "Mechanism-Driven Catalyst Design for Sustainable Coupling Chemistry"
- 08/24/2018 SUNY Binghamton, Binghamton, NY "Mechanism-driven Catalyst Design for Sustainable Coupling Chemistry"
- 07/19/2018 Organic Reactions & Processes Gordon Research Conference (short talk), Stonehill College, Easton, MA "Electrophilic Concerted Metalation-Deprotonation (eCMD): A Distinct C-H Activation Mechanism Enables Mild Dehydrogenative Coupling"
- 07/12/2018 Organometallics Gordon Research Conference (short talk), Salve Regina University,

- Newport, RI “Very Low Coordinate Late Metal Complexes”
- 03/22/2018 ACS National Meeting, New Orleans “Unstable Boronic Acid and Pinacol Ester Cross-Coupling”
- 01/22/2018 Boston University, Boston, MA “Mechanism-driven catalyst design for sustainable chemistry”
- 12/05/2017 Celgene Research & Development, Summit, NJ “Leveraging non-covalent forces in the design of metal catalysts with improved performance and selectivity”
- 10/24/2017 Syracuse University, Syracuse, NY “Targeting non-covalent forces in the design of metal catalysts with improved performance and selectivity”
- 08/24/2017 ACS National Meeting, Washington D.C. “Direct boronic acid transmetalation to a Pd(II) halide”
- 08/20/2017 ACS National Meeting, Washington D.C. “Mechanism, rate, and selectivity consequences of sulfur ligands in cross-dehydrogenative coupling”
- 07/04/2017 University of Tokyo, Tokyo, Japan “Direct Boronic Acid Transmetalation”
- 06/06/2017 ACS Mid-Atlantic Regional Meeting (MARM) 2017, Hershey, PA “Leveraging P(III)-P(V) Oxide Ligands”
- 02/05/2017 King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia “Leveraging P(III)-P(V) Oxide Ligands: Enabling Polar Alkene Polymerization by Group 10 Metals”
- 09/30/2016 ExxonMobil Research and Engineering, Baytown, TX “Cationic Group 10 Catalysts For Linear-Selective Copolymerization”
- 09/27/2016 Drew University, Madison, NJ “In Search of Simple Design Principles for Next Generation Transition Metal Catalysts”
- 09/03/2016 CREST Base Metal Symposium, Princeton University, Princeton, NJ, “Leveraging P(III)-P(V) Oxide Ligands to Enable Polar Alkene Polymerization with a Base Metal”
- 08/23/2016 Oligomers & Polymers with Precisely Designed Microstructures: Synthesis, Properties & Applications Symposium, PMSE Division, ACS Fall National Meeting, Philadelphia, PA, “Linear Copolymers of Ethylene and Polar Alkenes Generated by Cationic Group 10 Catalysts”
- 09/12/2015 Philadelphia Inorganic Colloquium, The College of New Jersey, Trenton, NJ, “Hard Ligands for Soft Metals: Controlling Group 10 Olefin Polymerization Catalysts with New P(V)-Based Oxygen Ligands”
- 02/20/2015 ExxonMobil Central Research & Engineering, Annandale, NJ “Thermally Robust, Linear

Selective, Cationic Palladium Catalysts For Copolymerization of Ethylene and Polar Alkenes”

- 06/14/2013 International Symposium on Homogeneous Chemical Reactivity, Ibaraki University, Mito, Japan, “Development of Cationic Bisphosphine Monoxide-Palladium Catalysts for the Non-Alternating Copolymerization of Ethylene and Acrylates”
- 09/13/2012 59<sup>th</sup> Symposium on Organometallic Chemistry, Osaka University, Osaka, Japan, “Synthesis of Functional Polyolefins Using Cationic Bisphosphine Monoxide-Palladium Complexes”
- 07/23/2012 Iowa State University, Ames, IA, “Functional Polyolefin Synthesis”
- 11/21/2009 23<sup>rd</sup> Annual Organic Area Allerton Conference, University of Illinois at Urbana-Champaign, Urbana, IL, “Mechanistic Studies in Palladium Catalysis: The Role of Ligandless, Anionic Arylpalladium Halide Intermediates in the Mizoroki-Heck Reaction”
- 08/20/2009 Global Center of Excellence Program Summer School, Tohoku University, Sendai, Japan, “Mechanistic Studies in Palladium Catalysis: The Role of Ligandless, Anionic Arylpalladium Halide Intermediates in the Mizoroki-Heck Reaction”
- 02/23/2009 Pines Travel Award Seminar, Missouri University of Science and Technology, Rolla, MO, “Mechanistic Studies in Palladium Catalysis: Observation of Unusual Intermediates from Complexes of P<sup>t</sup>Bu<sub>3</sub>”
- 03/28/2005 Materials Research Society Conference, Symposium B: Materials, Technology, and Reliability of Advanced Interconnects, “A Cross-Linkable Poly(p-xylylene) Derivative to Protect Ultra-Low  $\kappa$  Dielectrics”

## AWARDS AND HONORS

- 2018 NIH MIRA Award
- 2017 NSF CAREER Award
- 2017 Thieme Chemistry Journal Award
- 2011 Japan Society for the Promotion of Science (JSPS) Global COE Fellowship (U. Tokyo)

## PUBLICATIONS

1. Wang, L.; Carrow, B.P. " Oligothiophene Synthesis by a Distinct, General C–H Activation Mechanism: *Electrophilic Concerted Metalation-Deprotonation (eCMD)*" *ChemRxiv*, **2018**. DOI: 10.26434/chemrxiv.7496306.v1
2. McAlpine, N.J.; Wang, L.; Carrow, B.P. " A Diverted Aerobic Heck Reaction Enables Selective 1,3-Diene and 1,3,5-Triene Synthesis through C–C Bond Scission" *J. Am. Chem. Soc.* **2018**, *140*, 13634–13639.
3. Zhang, W.; Waddell, P.M.; Tiedemann, M.A.; Padilla, C.E.; Mei, J.; Chen, L.; Carrow, B.P. “Electron-Rich Metal Cations Enable Synthesis of High Molecular Weight, Linear Functional Polyethylenes” *J. Am. Chem. Soc.* **2018**, *140*, 8841–8850.

4. Chen, L.; Francis, H.; Carrow, B.P. "An 'On-Cycle' Precatalyst Enables Room-Temperature Polyfluoroarylation Using Sensitive Boronic Acids" *ACS Catal.* **2018**, *8*, 2989–2994. "Most Read Article" April 2018
5. Mitsushige, Y.; Yasuda, H.; Carrow, B.P.; Ito, S.; Kobayashi, M.; Tayano, T.; Watanabe, Y.; Okuno, Y.; Hayashi, S.; Kuroda, J.; Okumura, Y.; Nozaki, K. "Methylene-Bridged Bisphosphine Monoxide Ligands for Palladium-Catalyzed Copolymerization of Ethylene and Polar Monomers" *ACS Macro Lett.* **2018**, *7*, 305-311.
6. Chen, L.; Sanchez, D.R.; Zhang, B.; Carrow, B.P. "'Cationic' Suzuki–Miyaura Coupling with Acutely Base-Sensitive Boronic Acids" *J. Am. Chem. Soc.* **2017**, *139*, 12418-12421.
7. Gorsline, B.J.; Wang, L.; Ren, P.; Carrow, B.P. "C–H Alkenylation of Heteroarenes: Mechanism, Rate, and Selectivity Changes Enabled by Thioether Ligands" *J. Am. Chem. Soc.* **2017**, *139*, 9605-9614.
8. Carrow, B.P.; Chen, L. "Tri(1-adamantyl)phosphine: Exceptional Catalytic Effects Enabled by the Synergy of Chemical Stability, Donicity, and Polarizability" *Synlett* **2017**, *28*, 280-288.
9. Chen, L.; Ren, P.; Carrow, B.P. "Tri(1-adamantyl)phosphine: Expanding the Boundary of Electron-Releasing Character Available to Organophosphorus Compounds" *J. Am. Chem. Soc.* **2016**, *138*, 6392-6395. Highlighted in *Chemical & Engineering News and Org. Process Res. Dev.* (doi: 10.1021/acs.oprd.6b00218)
10. Bui, P.B.; Oyama, S.T.; Takagaki, A.; Carrow, B.P.; Nozaki, K. "Reactions of 2-Methyltetrahydropyran on Silica-Supported Nickel Phosphide in Comparison with 2-Methyltetrahydrofuran" *ACS Catal.* **2016**, *6*, 4549–4558.
11. Mitsushige, Y.; Carrow B.P.; Ito, S.; Nozaki, K. "Ligand-Controlled Insertion Regioselectivity Accelerates Copolymerization of Ethylene with Methyl Acrylate by Cationic Bisphosphine Monoxide–Palladium Catalysts" *Chem. Sci.* **2016**, *7*, 737-744.
12. Carrow, B.P.; Nozaki, K. "Transition-Metal-Catalyzed Functional Polyolefin Synthesis: Effecting Control through Chelating Ancillary Ligand Design and Mechanistic Insights" *Macromolecules* **2014**, *47*, 2541-2455. "Most Read Article" May 2014
13. Nakamura, N.; Kageyama, T.; Goto, H.; Ito, S.; Carrow, B.P.; Nozaki, K. "P-Chiral Phosphine–Sulfonate/Palladium-Catalyzed Asymmetric Copolymerization of Vinyl Acetate with Carbon Monoxide" *J. Am. Chem. Soc.* **2012**, *134*, 12366-12369.
14. Carrow, B.P.; Nozaki, K. "Synthesis of Functional Polyolefins Using Cationic Bisphosphine Monoxide–Palladium Complexes" *J. Am. Chem. Soc.* **2012**, *134*, 8802-8805.
15. Carrow, B.P.; Hartwig, J.F. "Distinguishing Between Pathways for Transmetalation in Suzuki–Miyaura Reactions." *J. Am. Chem. Soc.* **2011**, *133*, 2116-2119.
16. Carrow, B.P.; Hartwig, J.F. "Ligandless, Anionic, Arylpalladium Halide Intermediates in the Heck Reaction." *J. Am. Chem. Soc.* **2010**, *132*, 79-81.
17. Barrios-Landeros, F.; Carrow, B.P.; Hartwig, J.F. "Effect of Ligand Steric Properties and Halide Identity on the Mechanism for Oxidative Addition of Haloarenes to Trialkylphosphine Pd(0) Complexes" *J. Am. Chem. Soc.* **2009**, *131*, 8141-8154.

18. Barrios-Landeros, F.; Carrow, B.P.; Hartwig, J.F. "Autocatalytic Oxidative Addition of PhBr to Pd(P<sup>t</sup>Bu<sub>3</sub>)<sub>2</sub> via Pd(P<sup>t</sup>Bu<sub>3</sub>)<sub>2</sub>(H)(Br)" *J. Am. Chem. Soc.* **2008**, *130*, 5842-5843.
19. Senkevich, J.J.; Carrow, B.; Wang, P.-I. "Thermal and Dielectric Stability of Parylene X." *Mater. Res. Soc. Symp. Proc.* **2006**, *914*, 101-106.
20. Senkevich, J.J.; Woods, B.W.; Carrow, B.P.; Geil, R.D.; Rogers, B.R. "Amorphous Highly Conjugated Chemical-Vapor-Deposited Polymer Thin Films." *Chem. Vapor Dep.* **2006**, *12*, 285-289.
21. Carrow, B.P.; Bakhru, H.; Wang, P.-I.; Chen, Y.; Senkevich, J. J. "Dehydrohalogenation in Alpha-Functionalized Poly-p-xylylenes." *Chem. Vapor Dep.* **2006**, *12*, 239-244.
22. Senkevich, J.J.; Carrow, B.P.; Woods, B.W.; Bae, D.-L.; Cale, T.S.; Wang, P.-I. "Molecular Caulk: Enabling Aspects for Ultra-Low  $\kappa$  Dielectric Integration." *Advanced Metallization Conference, Proceedings of the Conference*, **2006**, 375-379.
23. Carrow, B.P.; Murray, R.E.; Woods, B.W.; Senkevich, J.J. "Poly(ethynyl-p-xylylene), an Advanced Molecular Caulk CVD Polymer" *Mater. Res. Soc. Symp. Proc.* **2005**, *863*, 189-194.
24. Ye, D.-X.; Carrow, B.; Pimanpang, S.; Bakhru, H.; Ten Eyck, G. A.; Wang, G.-C.; Lu, T.-M. "Evaluation of a Novel Cu(I) Precursor for Chemical Vapor Deposition" *Electrochem. Solid-State Lett.* **2005**, *8*, C85-C88.

## PATENTS

Carrow, B.P.; Chen, L. "Tri(1-adamantyl)phosphine and Applications Thereof" WO 2017/075581 A1, May 4, 2017.

Carrow, B.P.; Zhang, W. "Transition Metal Catalysts for Olefin Polymerization" WO 2015/200849 A2, December 30, 2015.

Nozaki, K.; Carrow, B.; Okumura, Y.; Kuroda, J. "Catalyst for Synthesizing Polyolefins" WO 2013/168626 A1, November 11, 2013.