

THE ALEXANDER M. CRUICKSHANK LECTURESHIP

Catalysis with Earth-Abundant Metals: Bond-Formation in Strong versus Weak Ligand Fields

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Transition metal catalysis has revolutionized chemical synthesis. Transformations such as metal-catalyzed cross-coupling, asymmetric hydrogenation, olefin metathesis, and C–H functionalization have reshaped how chemists construct bonds and, in doing so, expanded accessible molecular space. Historically, these reactions have relied on closed-shell, precious-metal complexes that undergo predictable two-electron redox processes. The growing emphasis on sustainability has prompted a shift toward earth-abundant first-row transition metals, including manganese, iron, cobalt, and nickel. These elements feature weaker ligand fields, accessible one-electron redox chemistry, and frequently open-shell metal complexes. As a result, the fundamental organometallic principles needed to understand and optimize their reactivity remain comparatively underdeveloped.

My lecture will present our work on developing catalysts with earth-abundant transition metals and understanding the fundamental organometallic chemistry of how they operate. Special emphasis will be placed on how controlling the ligand field strength alters the fundamental reactivity and ultimately the application of the catalyst.

Transformations such as the site-selective functionalization and hydrogenation of (hetero)arenes and new methods for carbon-carbon bond formation will be discussed.



Paul J. Chirik is the Edwards S. Sanford Professor of Chemistry and Chair of the Princeton Chemistry Department. Chirik is a synthetic chemist with broad interests in catalysis and sustainability. His research is focused on understanding the catalytic and fundamental organometallic chemistry of earth abundant, first-row transition metals such as iron, manganese, cobalt and nickel. Catalysts developed in Chirik's laboratory have found application in the synthesis of commercial silicones, active pharmaceutical ingredients, and carbon-neutral fuels. A native of Philadelphia, Pennsylvania, he obtained his B. S. in chemistry at Virginia Tech where in the laboratory of Joseph Merola, his interest in the chemistry of the transition metals began. Chirik earned his Ph. D. at Caltech under the supervision of John Bercaw and following a brief postdoctoral appointment at MIT, began his independent career at Cornell in 2001. In 2006, he was promoted to Associate Professor and in 2009 was named the *Peter J. W. Debye Professor of Chemistry*. In 2011, Chirik and his research group moved to Princeton University where

he was named the *Edwards S. Sanford Professor of Chemistry*. His teaching and research have been recognized with an Arthur C. Cope Scholar Award, the Blavatnik Award for Young Scientists, a Packard Fellowship in science and engineering, the 2016 Presidential Green Chemistry Challenge Award, the 2017 the 2019 Eni Environmental Solutions Prize, the Gabor Samorjai Award for Creative Research in Catalysis, the Linus Pauling Medal and the 2027 ACS Award in Organometallic Chemistry. Chirik is the author of over 300 peer-reviewed publications, inventor on more than 20 patent applications and current Editor-in-Chief of *Organometallics*.