

# Hydrocarbon functionalization and upgrading with Earth abundant metal catalysts

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## Hydrocarbon functionalization and upgrading with Earth abundant metal catalysts

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Transition metal catalyzed reactions have revolutionized chemical synthesis as applied to the preparation of bioactive molecules and drug compounds. Most of these transformations rely on the least abundant elements in the Earth's lithosphere – palladium, iridium and rhodium – and raise concerns about toxicity and sustainability. My lecture will focus on catalysis with Earth abundant transition metals that, in addition to cost and environmental advantages, offers unique reactivity that will enable new methods for the manipulation and functionalization of abundant hydrocarbons. Applications range from the upgrading of commodity olefins such as ethylene, propylene and butadiene (*Science* **2015**, 349, 960) to the radiolabeling of drug-like lead compounds (*Nature* **2016**, 529, 195). Rational control the electronic structure of cobalt catalysts has resulted in highly active catalysts for the C(sp<sup>2</sup>)-H (*J. Am. Chem. Soc.* **2014**, 136, 4133) and C(sp<sup>3</sup>)-H bonds (*J. Am. Chem. Soc.* **2016**, 138, 766). More recent studies have focused on both cobalt and more recently nickel compounds for the polyfunctionalization of C(sp<sup>3</sup>)-H bonds where multiple C-H bonds on a single carbon are transformed into functional groups. These methods do not rely on directing groups but rather inherent electronic and steric differences associated with specific carbon-hydrogen bonds. A third area of interest, conducted in collaboration with Bristol-Myers Squibb, explores new iron and cobalt catalysts as alternatives to palladium for the most widely applied carbon-carbon bond forming reactions utilized in the pharmaceutical industry. The structural similarity among ligand platforms culminates in a new method for one-pot site selective C-H arylation in the absence of directing groups using an Earth abundant metal catalyst. The electronic structure of the catalyst precursors, the organometallic chemistry of relevant intermediates and the mechanisms of catalytic turnover will be an emphasized throughout.

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Paul CHIRIK was born in 1973 outside of Philadelphia, PA. In 1995 he earned his Bachelor of Science in Chemistry from Virginia Tech. During that time, he conducted undergraduate research with Professor Joseph S. Merola studying aqueous iridium chemistry. Chirik earned his Ph. D. with Professor John Bercaw at Caltech in 2000 and was awarded the Hebert Newby McCoy award for his dissertation on metallocene catalyzed olefin polymerization. After a brief postdoctoral appointment with Professor Christopher Cummins at MIT, Chirik began his independent career at Cornell University 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 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, a Camille Dreyfus Teacher Scholar Award and an NSF CAREER Award. He is currently the Editor-in-Chief of *Organometallics* and Associate Director of the Andlinger Center for Energy and the Environment.