Sustainable Catalysts for the 21st century: Using first-row transition metals to advance C-H bond activation and C-C bond formation

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Sustainable catalysis is an important goal for the 21st century, using more abundant and biologically benign metals such as iron in traditional catalytic reactions like C-C cross coupling and C-H bond activation eliminates the need to spend enormous amounts of energy and resources extracting precious metals from the Earth and then removing them from the products and waste streams we generate using these metals for catalysis. I will begin by presenting my past research on selective oxidation of alkanes using sustainable metal catalysts. Four structurally identical catalysts, each incorporating a different metal center (Fe, Co, Ni, and Cu), were subjected to oxidative conditions in the presence of an alkane and the kinetic profiles and product distributions of these reactions was examined to determine the reactivity and selectivity of the individual metals in this complex reaction network. Variations in the resulting oxidation products suggest subtle changes in the rate law that allow Ni for example to be the most effective and selective producer of alcohol while Co is the most effective and selective producer of ketone in the given reactions. The kinetic profiles depict a unique mechanism for each of the four catalysts, concentration vs. time plots of these catalysts demonstrate that while Fe, Co, and Ni all operate as effective catalysts in this reaction, Fe behaves more as an initiator while Ni operates as a unimolecular catalyst and Co appears to potentially operate as a bimolecular catalyst for these reactions. Also covered will be the exciting upcoming work of the Basemann Lab. Areas of interest are in the realm of iron catalyzed reactions particularly those in which C-C bonds are formed and C-H bonds are activated by low valent iron catalysts.