THE IRON AGE OF CATALYSIS: A WORLD OF OPPORTUNITIES

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The continuous effort to present a more sustainable outlook for future generations has led to a renaissance in the use of earth-abundant metals in homogenous catalysis. Their natural abundance, low-toxicity, and ready availability have been strong incentives to replace their less environmentally friendly noble metal counterparts. In addition, the smaller ionic radii and typically high-spin electronic structure of earth-abundant metals have resulted in unique reactivity that can be otherwise hard to realize with their heavier congeners. Nonetheless, there are only a few examples of earth-abundant metal catalyst that can achieve noble-metal like reactivity. In this lecture, emphasis will be placed upon a new ligand design that features a central N-heterocyclic carbene (NHC) in a pincer type geometry. The resulting metal complexes of manganese, cobalt and particular iron will be evaluated for their catalytic properties. We will consider the effect of oxidation and spin-state of the observed reactivity and demonstrate that iron is indeed able to achieve noble-metal like reactivity. We will emphasize the role of two-electron chemistry in the reactivity and explore different reactions such as alkene isomerization **(Figure 1**), hydrogen isotope exchange, acceptorless dehydrogenation, and the various aspects of C−H bond activation.1-2 Overall, in this lecture it will be clear that earth-abundant metals are indeed able to break barriers in chemistry, and prepare the way for a new “iron-age” in catalysis.

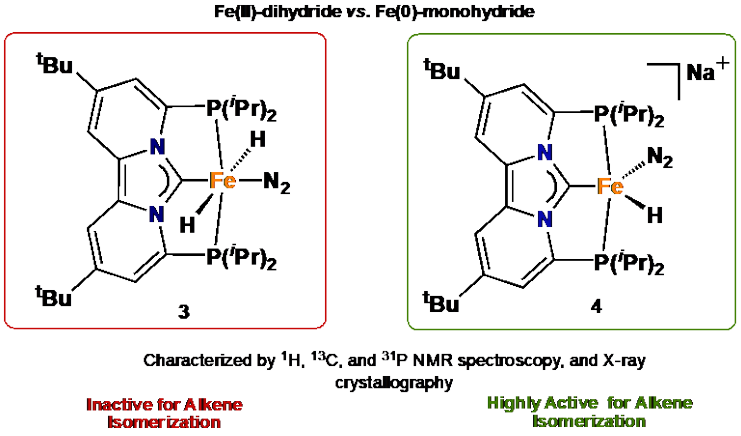

Figure 1 | Iron catalyst for alkene isomerization. Difference in oxidation and spin-state result in vast differences in reactivity for selective one-bond alkene isomerization.

References

[1] Garhwal, S.; Kaushansky, A.; Fridman, N.; Shimon, L. J. W.; and de Ruiter, G. *J. Am. Chem. Soc.* **2020**. *142*, 17131.

[2] Garhwal, S.; Kaushansky, A.; Fridman, A.; and de Ruiter, G. *Chem Catalysis*, **2021**, *1*, 631.