Frustrated Lewis Pairs: New Directions

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Over the last 15 years, the concept of frustrated Lewis pairs (FLPs) has emerged as an approach to transition metal-free hydrogenations as well as the activation of a wide range of small molecules. Indeed, the catalytic reductions of a wide variety of organic substrates, as well as the elegance of enantioselective metal-free hydrogenations have been developed. FLPs have been shown to react with or capture a wide variety of small molecules including but not limited to CO_2, CO, SO_2, N_2O, olefins and alkynes. More recently, we have developed a catalytic hydrogenation of CO_2 using and an FLP to mediate the catalytic reduction of CO_2 using H_2 in the present of a silylhalide. This strategy allows the selective formation of disilylacetal, methoxysilane, methyliodide and methane depending on the specific reactions conditions.

In another direction, we have extended the generality of concept of FLP chemistry to group 1, alkali metal species. For example, we demonstrated that alkali-metal phosphides and amides behave as FLPs, activating H2 and mediating hydrogenation of imines and olefins. In addition, we showed that such FLPs can also react with CO providing a preparative route to isocyanides. Moreover, under differing conditions, these FLPs can affect the homologation of CO, or provide a unique route to a hexa-substituted benzene. Finally using "syn-gas", we have achieved Fischer-Tropsch reactivity, providing a transition metal-free route to sequential C-C and C-H bond formations.

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Douglas W. Stephan, born in Hamilton, grew up in the Hamilton suburb of Stoney Creek. He attended McMaster University where he obtained his Bachelor of Science Degree in 1976 (summa cum laude). Afterwards, he began his Ph.D., studies in Chemistry at the University of Western Ontario with an NSERC of Canada postgraduate fellowship. Upon completion of his Ph.D. in 1980, he became a NATO Postdoctoral Fellow with Prof. R. H. Holm at Harvard University. In 1982, he became an Assistant Professor at the University of Windsor and quickly rose the ranks becoming a Full Professor in 1992 and University Professor in 2002. In 2008, he took up a position as Professor of Chemistry and Canada Research Chair in Inorganic Materials and Catalysis at the University of Toronto. The Canada Research Chair was renewed in 2015 and in 2018 he was named a "University Professor" at U of T. He was an Einstein Visiting Fellow at TU-Berlin from 20216-2019 and in 2020, he established an additional satellite laboratory at Ningbo University as a Zhedong Scholar Chair Professor. He was an Associated Editor for Chemical Society Reviews for 6 years, the Chair of the editorial board and is now Chair of the editorial board of Chemical Communications. He also sits on the Editorial board of the Royal Society (UK) journal, Philosophical Transactions A and on the advisory board for the Berlin-Potsdam cluster of excellence in catalysis. In his independent research career, Stephan has published over 540 scientific articles with over 300 papers since 2008. He has given over 320 invited lectures. His research has led to major fundamental advances in chemistry and had a practical impact on commercial processes. Stephan's papers have been exceptionally highly cited with over 40000 citations, a remarkable level for an inorganic chemist. The innovative and pragmatic nature of his work is evidenced by ca. 90 patent applications filed by industrial partners. He has trained more than 65 PhD and MSc students, and over 65 postdoctoral fellows in addition to over ca 150 undergraduates. He was honored with many awards and distinctions, e.g., F.A. Cotton Award in Synthetic Inorganic Chemistry (ACS, 2022), Centenary Prize (RSC, UK, 2021), Guggenheim Fellowship (John Simon Guggenheim Memorial foundation USA, 2020), Thomson Reuters Highly Cited Researcher (top 1% of all scientists) (2014-2019), Thomson Reuters, Most influential scientific minds (2015), Applied Catalysis Award (RSC, UK), Corresponding Member of North-Rhein-Westfaelia Academy of the Sciences and Arts (Germany, 2014), Honorary Member of the Israeli Chemical Society (2013).