Discovering New Reaction with CO$_2$

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Carbon dioxide (CO$_2$) is one of the major greenhouse gases in the atmosphere and the emission of CO$_2$ is increasing every year. The rising levels of atmospheric CO$_2$ have caused an increase in global temperatures. To tackle this Global issue, we aim at reaching NET Zero emission of CO$_2$, however, this requires a combined approach such as carbon capture and storage (CCS) and carbon capture and utilization (CCU). At present, we do not have any sustainable technology that can lead to NET ZERO emission. For example, with our current technology even we can achieve CCU with its best efficiency, it cannot consume more than 10% of total emitted CO$_2$. Thus, it requires discovery of new CO$_2$ utilization methods. However, activation and catalytic transformation of CO$_2$ has been thermodynamically challenging which often requires the use of transition metal-based catalyst. It is even more difficult when one wishes to accomplish without using a transition metal-based catalyst. Recently we discovered a new reaction with CO$_2$, where we utilized CO$_2$ as a coupling reagent to stitch two inert primary amide molecules under completely metal-free condition. In this work, we have synthesized a series of super nucleophilic mesoionic N-Heterocyclic Imines (mNHI). These were found to be highly capable toward the capture of CO$_2$ under ambient conditions. This super nucleophilicity of mNHI was utilized in the activation of two inert molecules amides and CO$_2$ to devise a strategy for the activation and catalytic reduction of CO$_2$ to methylene compounds through the coupling of amides and amines. In this process we developed two hitherto unknown reaction directly from CO$_2$.