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Understanding the electronic perturbation of metal catalysts toward a more efficient, less toxic catalyst for the electrochemical reduction of carbon dioxide to formate

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The second year of the proposed work has strengthened the new direction my lab has taken. My students spent a significant amount of time during the past year (including summer) developing new characterization methods for the formate that we are producing on Sn catalysts. Initially we had anticipated that UV spectroscopy would be sufficient for quantification, but we learned that separation was necessary. We proceeded to HPLC-UV in order to afford separation prior to UV analysis. But we found significant variation to the instrument response and decided that we could not achieve consistent results. We then proceeded to use deuterated water and proton NMR to quantify the formate. We found consistency between LC and NMR and then determined that the NMR was much more repeatable from day to day.

Using NMR, we have been able to better probe the impact of applied potential on quantity of formate produced during carbon dioxide reduction. Our first efforts were with Sn catalyst, but we have now progressed to analysis of carbon dioxide reduction on Zn, SnZn, and SnPd catalysts. We anticipate that we will find lower overpotentials (and fewer heavy metals) required using bimetallic (or even Zn) catalysts, and we are presently scanning various potentials to determine the quantity of formate produced.

This work continues to be the primary focus of several undergraduate students with work being performed year round under my mentorship.