Developing Catalysts for Renewable Fuel Synthesis

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A sweeping transition to clean energy sources is imperative in the wake of the climate crisis. However, common alternatives have limited applicability due to their relatively low energy densities. Batteries and hydrogen fuels—two prevailing solutions for alternative energy storage—require large volumes to store small quantities of energy. New technologies for high-density energy storage will help eliminate global dependence on fossil fuels. It is essential that these technologies don't further pollute the atmosphere, which is why synthetic liquid fuels are promising candidates.[1] Instead of drawing from non-renewable carbon resource pools underground, these fuels are synthesized with captured carbon dioxide gas, making the synthetic fuel cycle carbon neutral. My goals for the summer were to contribute to the Tate Lab's ongoing research into synthetic fuels while engaging with my community on the underlying issues that motivate the lab. With rapidly changing weather patterns and an economy that relies on natural resources, Maine is feeling the impacts of climate change acutely. In the face of such an anxiety inducing reality, the young people in our community deserve to be empowered to tackle the crisis head on, which is why I spent part of my summer educating students about the power of green chemistry.

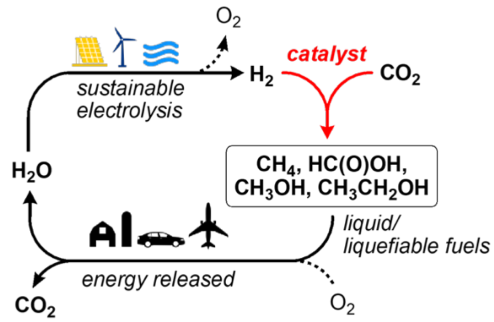

Figure 1: A diagram of the synthetic fuel cycle. The carbon dioxide hydrogenation reaction step, which is highlighted in red, requires a catalyst.

During my time in the Tate Lab, I focused on developing hard-soft acid-base mismatch catalysts to activate hydrogen for carbon dioxide hydrogenation, a critical reaction step in the synthetic fuel cycle. Our hydrogenation catalysts are unique and somewhat novel because they employ acid-base chemistry as opposed to redox chemistry, which is most common for hydrogenation catalysts but less suitable for our carbon dioxide substrate. As a result of their novelty, my primary responsibility in the lab was to refine the synthetic pathway to the catalysts' precursor.

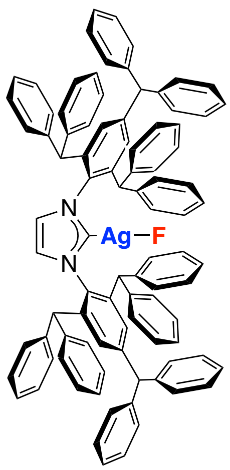

Figure 2: The chemical structure of an IPr# AgF catalyst that the Tate Lab is studying.

Beyond my lab work, I spent the first week of my summer with a small group of students and professors from Bowdoin in Calais, Maine, where we taught interactive science lessons to seventh graders from the Passamaquoddy Indian Township Reservation and the Sipayik Reservation. The lesson that I led explored the effects of climate change in Washington County and the ecosystem's inspiring resilience. Later in the summer, I partnered with the Curtis Memorial Library in Brunswick to put together an installation for their children's section that explained the importance of clean energy. Both experiences grounded me in the significance of my lab work and deeply enriched my summer.

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[1] Olah, Prakash, and Goeppert, "Anthropogenic Chemical Carbon Cycle for a Sustainable Future," *Journal of the American Chemical Society* 133, no. 12881–12898 (2011).