General Abstract K. Flynn

A mechanistic study of CO_2 reduction at the interface of a gallium phosphide (GaP) surface using core-level spectroscopy

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Global warming, due to greenhouse gases such as carbon dioxide (CO_2), has become an issue of global importance as worldwide temperature raises impacting natural landmarks such as glaciers melting. Since greenhouse gases trap excess heat from the sun, decreasing the concentration of CO_2 has become a critical component in developing a sustainable energy landscape with reduced impact on the environment. An attractive approach to address both environmental and energy needs is to chemically convert CO_2 using the sun as a potential energy source. These include novel electro- or photo-catalysts, substances that aid in the breaking and forming of bonds, which produce hydrogen and convert emitted CO_2 to fuels such as alcohols. Gallium phosphide (GaP), a semi-conductor, has been shown to selectively convert CO_2 to methanol in an aqueous solution. In this work, we aim to address the fundamental role of GaP during the catalytic conversion, by investigating the interaction between a clean GaP surface with the reactants, products, and intermediates of this reaction using X-ray spectroscopy. We have determined a procedure for preparing atomically clean GaP and our initial experiments of CO_2 adsorption indicated that CO_2 undergoes a chemical reaction with surface oxygen on the clean GaP surface creating CO_3^- even at liquid nitrogen temperatures (80K). As this result contradicts reported theoretical findings, we believe this discovery motivates further studies on CO_2 catalysis.

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