INORGANIC SEMINAR

"Efficient Conversion of Carbon Dioxide to Fuels using Bismuth Materials that Display Tunable Catalytic Profiles"

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Monday, October 22nd, 4:00pm

473 Hutchison Hall

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Abstract:

The electrochemical reduction of CO_2 provides a pathway to address current issues in solar energy storage and the sustainable production of fuels. Many such approaches, however, have been hampered by a lack of affordable platforms that can efficiently promote CO_2 valorization with high selectivity and reasonable kinetics. It is in response to this need that we have developed inexpensive cathode materials comprised of post-transition metals for conversion of CO_2 to CO, HCO_2H and other value-added reduced carbon compounds. We find that these platforms are easily prepared and the outcome of CO_2 conversion can be tuned in the presence of varied room-temperature ionic liquids (RTILs). For example, we have prepared and studied a class of bismuth-based materials that promotes the reduction of CO_2 to CO with fast kinetics and high efficiencies in the presence of imidazolium ($[Im]^+$) based RTILs. A multi-pronged initiative has elucidated the mechanistic pathways and molecular design principles that drive conversion of CO_2 to CO at the Bi/$[Im]^+$ interface. We will discuss how integrated spectroscopic (XPS, XAS, XR, etc.) electroanalytical and computational methods have been used to interrogate the dynamics between electrocatalyst, RTIL and CO_2 at the cathode/electrolyte interface to provide insight into the pathway(s) by which the Bi/$[Im]^+$ platform activates CO_2. We have also evaluated the electrochemistry of the Bi-cathodes in the presence of non-$[IM]^+$ RTILs. These studies reveal that subtle modification of the RTIL structure, leads to a significantly different catalysis with CO_2. Electrolysis of CO_2 over Bi in the presence of RTILs generated from the organic base DBU promotes the reduction of CO_2 to yield formate (instead of CO) via an orthogonal CO_2 activation pathway. The 'catalytic plasticity' that is displayed by Bi/[RTIL] platforms, along with implications for future discovery of catalyst/electrolyte combinations that can enable CO_2 conversion and solar fuels production will be discussed.

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