Shaping the energy landscape toward renewable energy resources is a contemporary challenge that will require significant advancements in the development of catalysts/electrocatalysts for energy and chemical conversion. The goal of our research group is to design active, selective and stable heterogeneous catalysts and electrocatalysts for energy and chemical conversion processes. We have focused on utilizing the versatile structure of non-stoichiometric mixed metal oxides, along with controlling the 3-dimensional environment of heterogenous catalytic sites via "inverted" catalytic architectures, as potential avenues for addressing limitations with the current state-of-the-art catalytic/electrocatalytic systems.

In this presentation, I will discuss our work on designing non-stoichiometric mixed metal oxide electrocatalysts for electrochemical oxygen reduction and evolution reactions (ORR/OER). These processes play an important role in electrochemical energy conversion and storage technologies, such as fuel cells and electrolyzers. We have utilized a combination of controlled synthesis, kinetic analysis, advanced characterization and ab initio calculations to identify the factors that govern the activity and stability of non-stoichiometric mixed metal oxide electrocatalysts with the aim of identifying cost-effective, active and stable electrocatalysts for oxygen reduction and evolution.

In the second part of my talk, I will highlight our efforts on controlling the 3-dimensional environment of heterogeneous catalytic sites via "inverted" metal@metal oxide catalytic architectures or surface bound ligands on metal nanoparticles as levers to tune activity/selectivity in thermal catalytic reactions. Specifically, I will discuss our recent work on utilizing reducible metal oxide encapsulated noble metal catalytic structures to promote hydrodeoxygenation (HDO) of biomass-derived compounds. We have demonstrated that the enhancement in HDO activity/selectivity induced by the encapsulation of the metal nanoparticles with an oxide film results from the high interfacial contact between the metal and metal oxide sites, and the restrictive accessible conformations of aromatics on the metal surface.

NOTE: CCST SEMINARS/ZOOMS are scheduled at E.S.T./E.D.T.