

Enabling Sustainable Non Noble Metal Electrocatalysts for Oxygen Reduction Reaction

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Enabling concerted charge transfer at the inner Helmholtz plane of an electrochemical interface is a prelude to higher selectivity and activity for electrochemical processes hitherto not possible with conventional highly dispersed metal and metal alloy electrocatalysts. This presentation will focus on recent shifts away from conventional supported metal and metal oxide based catalysts to organo-metallic and composite metal oxides based structures, which promise orders of magnitude higher turnover frequency and selectivity. Taking oxygen reduction as a theme, this presentation will provide clear comparison of electrochemical response between supported metal catalysts (alloys and oxides), especially on noble metals in acidic pH and catalyst based on transition metal nitrogen coordinated systems and multi-phase composite oxides. Electrochemical data will be discussed in the context of spectroscopy, especially *in situ* synchrotron x-ray absorption spectroscopy (XAS). Here the conventional bulk averaged XANES and EXAFS spectroscopy will be further embellished by unique use of subtractive method referred to as ' $\Delta \mu$ technique'. This specially designed subtractive technique using the near edge part of the spectra (x-ray absorption near edge spectra, XANES) has been previously validated and has unprecedented ability to elucidate nature of adsorbed species on transition metals. The unique element specificity and the *in situ* and *operando* capability of the XAS spectra in close conjunction with electrochemical data will be used to provide insight on steady state electrocatalytic pathways as a function of various operating conditions and associated applications. Unique structural features of the active sites determined *in situ* using the extended part of the spectra (i.e., extended x-ray absorption spectra, EXAFS) will be invoked to explain activity difference based on pH and water activity.