**Name:** Tianrang Yang  

**Presentation title:** Fundamentals of SrCoO$_{3-\delta}$ Based Oxygen-deficient Perovskites as Cathodes for Solid Oxide Fuel Cells

**Abstract:** The local structure and oxygen stoichiometry in oxide systems have a profound impact on oxygen electrocatalysis encountered in metal-air batteries and solid oxide fuel cells (SOFCs). However, this knowledge is often obtained under conditions different from the real working conditions of the material, resulting in misinterpretation and misunderstanding. This PhD dissertation aims to obtain the structure and oxygen-stoichiometry information of a class of perovskite oxides under their real working conditions in solid oxide fuel cells. Several perovskite oxides were selected for the study: Sr$_{0.9}$Y$_{0.1}$CoO$_{3-\delta}$ (SYC10), Sr$_{0.9}$Y$_{0.3}$CoO$_{3-\delta}$ (SYC30), SrCo$_{0.9}$Nb$_{0.1}$O$_{3-\delta}$ (SCN10) and SrCo$_{0.9}$Ta$_{0.1}$O$_{3-\delta}$ (SCT10).

The local crystal structure and oxygen stoichiometry of these materials were systematically characterized with *in-situ* neutron diffraction (ND). The oxygen stoichiometry was also measured by thermogravimetric analysis (TGA) and iodometric titration methods. To establish the correlation among structure, oxygen stoichiometry and oxygen reduction reaction (ORR) activity, high temperature electrochemical impedance spectroscopy, oxygen permeation and single cell testing were also performed. In chapter 2, SYC10 is described to have a more symmetrical structure and $V_0^{\cdot}$ distribution, and higher $V_0^{\cdot}$ concentration than SYC30. Molecular orbital energy analysis based on the local structure of the ORR-active Co1-polyhedra indicates SYC30 has a higher Fermi level relative to O-2p energy level in the active Co1-polyhedra, and thus a higher motional enthalpy for $V_0^{\cdot}$ migration. However, the ORR activity of Y-doped SrCoO$_{3-\delta}$ (SCO) are found uncompetitive with other popular catalysts. In chapter 3 and 4, systematic structural studies are presented for Nb and Ta-doped SCO, namely SCN10 and SCT10, respectively. The methodology of unrevealing the structure-activity relationships in chapter 2 is also found applicable to SYC10, SCN10 and SCT10 as presented in chapter 5. The electrochemical tests indicate that SCT10 is the best catalyst due to its excellent thermal and electrochemical stability. In chapter 6, SCT10 is evaluated in a real solid oxide fuel cell in the form of nanoscaled SCT10 layer coating on the commercial (La$_{0.6}$Sr$_{0.4}$)$_{0.95}$Co$_{0.2}$Fe$_{0.8}$O$_{3-\delta}$ (LSCF). The bilayer structured cathode shows excellent properties of coarsening-resistant, Sr-segregation-free and high ORR-activity.