University of Louisville
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Literature Seminar

When: February 2, 2023
Time: **12:00 p.m**.
Location: CBLL-16

Recent Advances in Development of Perovskite Oxides for Oxygen Reduction Reaction (ORR)

Abstract:

Energy conversion devices play a vital role in the development of society. Faced with challenges of traditional energy depletion and climate change, researchers are trying to find new environment-friendly and sustainable sources of energy, which also require advanced energy conversion and storage devices.[1] Fuel cells, and metal-air batteries, are considered promising technologies to meet the requirements of various applications. Fuel cells (FCs) can isothermally convert chemical energy stored in fuel and an oxidant into electrical energy, essentially a redox reaction. For energy conversion on an industrial scale, FCs face challenges, such as sluggish kinetics of the cathodic oxygen reduction reaction (ORR), costly catalysts, catalyst poisoning, etc. Therefore, the development of new and inexpensive catalysts has become an important direction in FC research. Perovskite oxides (ABO_3) have been investigated as bifunctional ORR/OER catalysts in alkaline electrolytes.[1, 2] Their compositions and properties can be finely tuned by partially substituting A and B with different metals. The application of these materials is hindered by the poor mass transfer and limited active sites. To address the problem, some researchers have worked on modifying perovskite oxides to adjust the electronic structure and chemical properties, and use them as electrode materials in FCs. In recent years, defect engineering has been an effective method to modify the properties and electronic structures of nanomaterials and has been widely used in electrode materials. Examples include doping of non-metals (such as P, B, N, etc.)[3], introducing A-site cation deficiency (without other modifications)[4], or modification of the surface structure of perovskite oxides by using lithium reduction, etc.[5] The presence of these defects affects the surrounding atoms and causes lattice distortion, which effectively regulates the electronic structure and chemical properties or electrical conductivity, which are ultimately crucial to the design of electrocatalysts for ORR applications.[1, 2]

References:

(1) Lang, P.; Yuan, N.; Jiang, Q.; Zhang, Y.; Tang, J. Recent Advances and Prospects of Metal-Based Catalysts for Oxygen Reduction Reaction. *Energy Technology* **2020**, *8* (3), 1900984.

(2) Huang, Z.-F.; Wang, J.; Peng, Y.; Jung, C.-Y.; Fisher, A.; Wang, X. Design of Efficient Bifunctional Oxygen Reduction/Evolution Electrocatalyst: Recent Advances and Perspectives. *Advanced Energy Materials* **2017**, *7* (23), 1700544.

(3) Li, Z.; Lv, L.; Wang, J.; Ao, X.; Ruan, Y.; Zha, D.; Hong, G.; Wu, Q.; Lan, Y.; Wang, C.; et al. Engineering phosphorus-doped LaFeO3-δ perovskite oxide as robust bifunctional oxygen electrocatalysts in alkaline solutions. *Nano Energy* **2018**, *47*, 199-209.

(4) Zhu, Y.; Zhou, W.; Yu, J.; Chen, Y.; Liu, M.; Shao, Z. Enhancing Electrocatalytic Activity of Perovskite Oxides by Tuning Cation Deficiency for Oxygen Reduction and Evolution Reactions. *Chemistry of Materials* **2016**, *28* (6), 1691-1697.

(5) Ou, G.; Yang, C.; Liang, Y.; Hussain, N.; Ge, B.; Huang, K.; Xu, Y.; Wei, H.; Zhang, R.; Wu, H. Surface Engineering of Perovskite Oxide for Bifunctional Oxygen Electrocatalysis. *Small Methods* **2019**, *3* (2), 1800279.