Earth Abundant Electrocatalysts for Hydrogen Energy Conversion and Storage

*Chuan Zhao*

School of Chemistry, UNSW Sydney, NSW2052, Australia*.*

The increasing demands for clean energy have triggered tremendous research interests on electrochemical energy conversion and storage systems with minimum environmental impact. Hydrogen holds the promise as energy carriers for global scale storage of renewable energy, e.g., solar and wind, enabling the continuous usage of these diffusive and intermittent energy sources when used together with fuel cells.1,2 Nevertheless, the widespread application of hydrogen technology has been severely constrained by the use of precious metal catalysts, such as oxides of ruthenium and iridium for the oxygen evolution reaction (OER), and platinum for the hydrogen evolution reaction (HER) and oxygen reduction reactions (ORR). Furthermore, electrochemical CO2 reduction reactions (CRR) and nitrogen reduction (NRR) provide alternative pathways for hydrogen storage and transport. These emerging technologies also call for highly efficient and selective catalysts to promote their industrial viabilities.

This presentation shows our efforts in developing non-precious metal-based, carbon-based and metal-organic framework-based electrocatalysts for key hydrogen conversion and storage reactions, as well as our strategies for enhancing these catalysts to a level comparable to that of precious metal catalysts.3-12 The commercialisation of some our catalysts in hydrogen industry also will be highlighted.

**References**

1. Smith, R. D. L.; Prevot, M. S.; Fagan, R. D.; Zhang, Z. P.; Sedach, P. A.; Siu, M. K. J.; Trudel, S.; Berlinguette, C. P. *Science* **2013**, 340, 60
2. Gong, M.; Li, Y. G.; Wang, H. L.; Liang, Y. Y.; Wu, J. Z.; Zhou, J. G.; Wang, J.; Regier, T.; Wei, F.; Dai, H. J. *J. Am. Chem. Soc.* **2013**, 135, 8452
3. Lu, X.; Zhao, C. *J. Mater. Chem. A*, **2013**, 1, 12053
4. Xiao, C. Lu, X.; Zhao, C. Chem. Comm., **2014**, 50, 10122
5. Lu, X.; Yim, W.; Bryan, B.H.R.; Zhao, C. J. Am. Chem. Soc., **2015**, 137, 2901
6. Lu, X.; Zhao, C. Nat. Commun., **2015**, 6, 6616
7. Xiao, C., Li, Yi. Lu, X. Zhao, C. Adv. Func. Mater. **2016**, 26, 3515
8. Li, Y.; Zhao, C. *Chem. Mater.* **2016**, 28, 5659
9. Li, Y.; Zhao, C. ACS Catal., **2017**, 7, 2535
10. Duan, J.; Chen, S.; Zhao, C. *Nat Commun.,* **2017**, 8, 15341
11. Li, Y.; Tan, X.; Chen, S.; Bo, X.; Ren, H.; Smith, S.; and Zhao, C., Angew. Chem. Int. Ed, **2019**, 58, 461-466
12. Ren, W., Tan, X., Yang, W., Jia, C., Xu, S., Wang, K., Smith, S.; and Zhao, C. Angew. Chem. Int. Ed, **2019**, 58, 6972-6976