Controlled synthesis of high-index faceted Pt nanocatalysts directly on carbon paper for methanol electrooxidation

Rui Huang, Ruiyi Ji, Chunhua Zhen, Shigang Sun
State Key Laboratory of Physical Chemistry of Solid Surfaces, Department of Chemistry, College of Chemistry and Chemical Engineering, Xiamen University, Xiamen 361005, China

Platinum (Pt) nanocatalysts as the best catalysts for direct methanol fuel cell (DMFC) still face a huge challenge such as high cost, low utilization rate, activity and stability to be improved. Adjusting the surface structure of Pt nanoparticles (NPs) to achieve high-index facets with more active sites is an effective method to resolve the problems. Furthermore, the controlled synthesis of high-index faceted Pt (HIF-Pt) nanocatalysts directly on carbon paper, which is an important component of membrane electrode, can greatly promote the practical application of HIF-Pt nanocatalysts in DMFC. Herein, the HIF-Pt nanocatalysts supported on carbon paper (HIF-Pt/CP) were realized by developing an electrochemically controlled synthesis method. The fishbone-like and concave cube shaped Pt NPs surrounded by some high-index facets such as (200), (220), and (311), were achieved by adjusting the frequency and treatment time of applied potential. Hence, these HIF-Pt/CPs exhibit excellent activity and stability towards methanol electrooxidation during both cyclic voltammetry characterization and potentiostatic test. Especially, the specific activities and mass activities of HIF-Pt/CP-1Hz reached 3.78 and 1.53 $A \cdot mg^{-1}$, which were 6.5 and 2.78 times higher than those of commercial Pt/C, respectively. It is worth mentioning that the direct growth of HIF-Pt NPs on carbon paper effectively reduces the contact resistance of the catalyst layer which shows great potential in the practical application in DMFC.

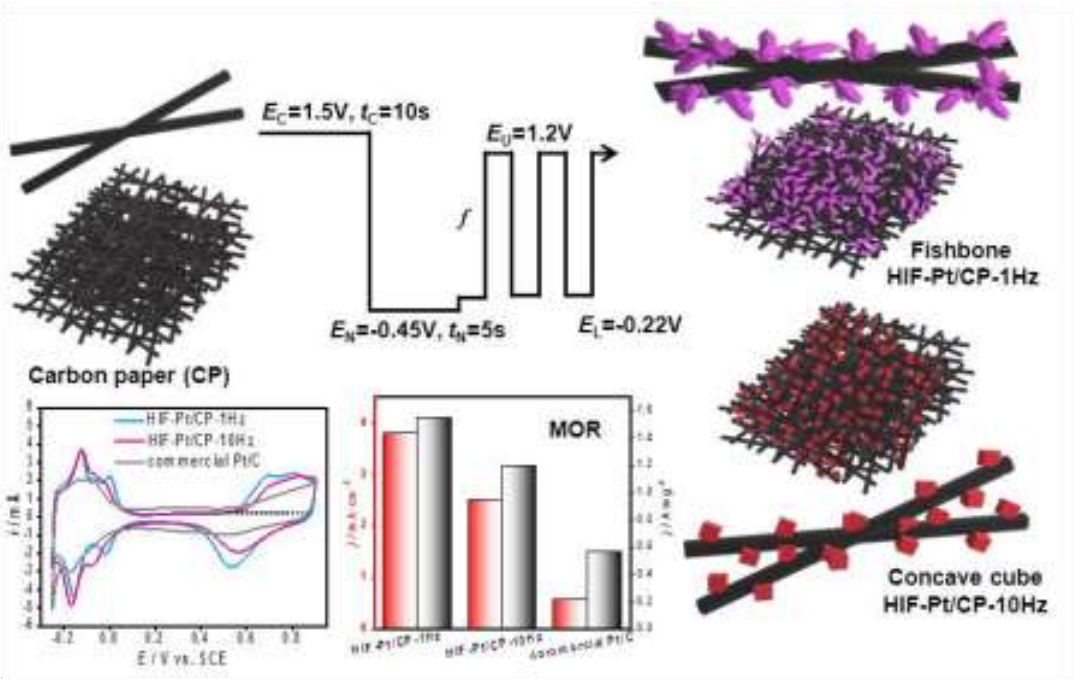

Figure 1. Carbon Paper supported High-index Faceted Pt Nanocatalysts and their catalytic performance

Acknowledgement: The studies were supported by Science and Technology Planning Project of Fujian Province (2022H002).

References

1. F. Xiao, Y.C. Wang, Z.P. Wu, G. Chen, F. Yang, S. Zhu, K. Siddharth, Z. Kong, A. Lu, J.C. Li, C.J. Zhong, Z.Y. Zhou, M. Shao, *Adv. Mater.* 33 (2021) 2006292s, https://doi.org/10.1002/adma.202006292
2. L. Huang, H.C. Xu, B. Jing, Q.X. Li, W. Yi, S.G. Sun, *J. Electrochem.* 28 (2022) 2108061s, https://doi.org/10.13208/j.electrochem.210806
3. M.S. Alias, S.K. Kamarudin, A.M. Zainoodin, M.S. Masdar, *Int. J. Hydrogen Energy* 45 (2020), 19620, https://doi.org/10.1016/j.ijhydene.2020.04.202