Heteroatom-Engineered Two-Dimensional Carbon Derived from Brassica Indica Seeds for High-Performance Oxygen Reduction Electrocatalysis

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Abstract

The preparation of low-cost and eco-friendly electrocatalysts for the oxygen reduction reaction (ORR) is essential for the promotion of fuel cells and metal-air batteries. In this study, we describe a biomass-based, heteroatom-doped two-dimensional (2D) carbon electrocatalyst prepared from Brassica indica seeds via a pyrolysis and activation process. The inherent heteroatom in the precursor allows for in situ doping of the carbon material, providing a high density of catalytic sites and a defective 2D structure. Structural and physical analyses verify the successful preparation of ultrathin carbon nanosheets with high surface area, improved electrical conductivity, and homogeneous heteroatom distribution. Electrochemical analysis shows that the ORR performance is highly superior in alkaline conditions, with a high onset potential, favorable half-wave potential, and a close to four-electron process. The improved ORR performance is ascribed to the unique synergistic effects of charge redistribution, optimized pore structure, and edge sites that are unique to the 2D structure. This work presents an effective method for converting biomass into high-performance electrocatalysts, providing a promising and green alternative to precious metal-based ORR catalysts for next-generation energy conversion applications.

References

[1] Anuj Kumar, Ying Zhang, Wen Liu, Xiaoming Sun, Coordination Chemistry Reviews, 2020, 213047
[2] Xin Feng, Ying Bai, Mingquan Liu, Ying Li, Haoyi Yang, Xinran Wanga and Chuan Wu, Energy and Environmental Science, 2021, 2036-2089
[3] Jintao Zhang, Liming Da, ACS Catalysis, 2015, 7244–7253
[4] Xiaoge Li, Bu Yuan Guan, Shuyan Gao and Xiong Wen (David) Lou, Energy and Environmental Science, 2019, 648-655