VIDEO ARTICLE

Vid. Proc. Adv. Mater., Volume 3, Article ID 2207348 **(2022)**

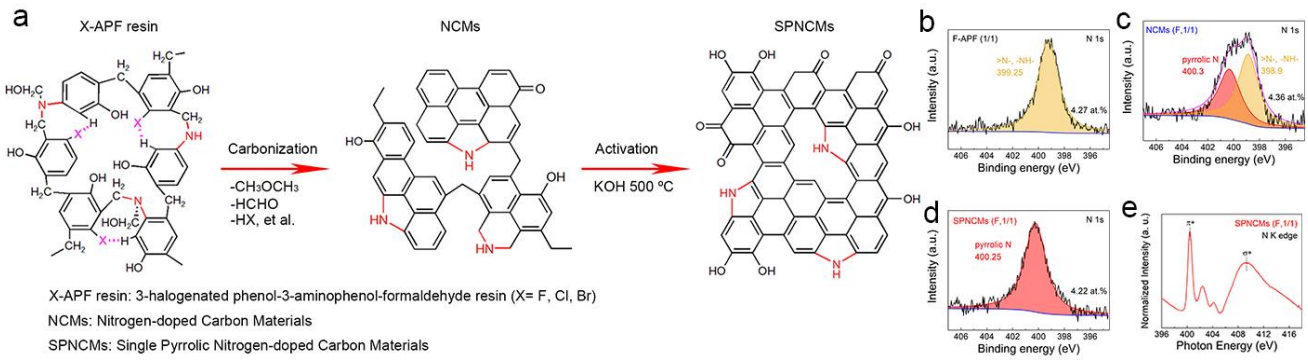
Single Pyrrolic Nitrogen Species-doped sp^2-Hybridized Carbon Materials to Elucidate Pseudocapacitance Site

Kesong Tian[1], Wanchun Guo[1,*], Haiyan Wang[1], Yanglong Hou[2]

[1]Yanshan University, Qinhuangdao, 066004, China
[2]Peking University, Beijing, 100871, China

*Corresponding author: E-mail: wc-g@ysu.edu.cn
DOI: 10.5185/vpoam.2022.07348

Graphical Abstract



Abstract

Introducing nitrogen species into sp^2-hybridized carbon materials has proved an efficient strategy to enhance their electrochemical performance. However, an inevitable existence of different nitrogen configurations in carbon materials, due to the uncontrolled transformation among different nitrogen configurations involved in fabricating nitrogen-doped carbon materials, largely limits the precise identification of electrochemically active nitrogen configurations for specific reactions.

In this talk, we will present our latest advances on single pyrrolic nitrogen species-doped sp^2-hybridized Carbon Materials to Elucidate Pseudocapacitance Site. Single pyrrolic nitrogen configuration-doped sp^2-hybridized carbon materials with a tuneable nitrogen content from 0 to 4.22 at.% were firstly synthesized via a combined strategy of low-temperature dehalogenation-induced and subsequent alkaline-activated pyrolysis of 3-halogenated phenol-3-aminophenol-formaldehyde co-condensed resins. In particular, two-step low-temperature pyrolysis achieves exclusive conversion of nitrogen-enriched groups to pyrrolic nitrogen configuration because high-temperature thermal treatment could trigger further uncontrolled conversion of pyrrolic to pyridinic and/or graphitic nitrogen configuration. The subsequent electrochemical analysis demonstrates that the pseudocapacitance of single pyrrolic nitrogen configuration-doped carbon materials is positively dependent on the pyrrolic nitrogen content, and there is the reversible conversion between pyrrolic

and oxidized pyrrolic nitrogen configuration during the multi-cycle charging/discharging processes. Thereby, it could be reliably inferred that pyrrolic nitrogen configuration is active pseudocapacitive site for nitrogen-doped carbon materials.

The discovery of single pyrrolic nitrogen configuration-doped carbon materials as ideal model carbon materials not only identifies pyrrolic configuration as active site and its mechanisms toward energy storage and conversion applications, but also offers a reliable strategy to finely tune structural nitrogen species in carbon materials for different energy conversion applications.

Keywords: Carbon materials; heterogenous atom, low-temperature pyrolysis, pyrrolic nitrogen, pseudocapacitance.

Acknowledgements

We thank the National Natural Science Foundation of China (51503178, 51631001, 51590882), National Key R&D Program of China (2017YFA0206301, 2016 YFA0200102) and Natural Science Foundation of Beijing Municipality (219001).

Reference

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Biography of Presenting Author

Wanchun Guo is the Associate Professor of the Department of Applied Chemistry at the Yanshan University. Dr. Wanchun Guo received his BS in Materials Chemistry from Tianjin University in China in 2005, and Ph.D. in Materials Science and Engineering from University of Science and Technology Beijing in China in 2013. Later, he joined the faculty at Yanshan University.

Current scientific interest: Rational design of heterogenous atom-doping carbon materials with single heterogenous atom configuration (pyrrolic, pyridinic, graphitic nitrogen, hydroxyl, carbonyl group, and so on) to precisely tailor the configurations of active sites for electrochemical energy storage, electrocatalysis, and to fundamentally understand their mechanisms for specific reactions.

Elucidating interfacial electron interaction between noble metal nanoparticles and conductive polymers such as polypyrrole and Poly(3,4-ethylenedioxythiophene), and clarifying the fundamental effect of electron structure of supported noble metal nanoparticles on catalytic performance for reduction of nitroaromatics.

Citation of Video Article

Vid. Proc. Adv. Mater., Volume 3, Article ID 2207348 **(2022)**
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