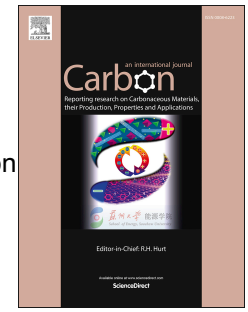
Accepted Manuscript



Nitrogen and boron co-doped hollow carbon catalyst for the oxygen reduction reaction

Ji-Sun Han, Dong Young Chung, Dae-Gwon Ha, Jin-Hong Kim, Keunsu Choi, Yung-Eun Sung, Shin-Hoo Kang

PII: S0008-6223(16)30279-2

DOI: 10.1016/j.carbon.2016.04.018

Reference: CARBON 10899

To appear in: *Carbon*

Received Date: 31 January 2016

Revised Date: 26 March 2016

Accepted Date: 7 April 2016

Please cite this article as: J.-S. Han, D.Y. Chung, D.-G. Ha, J.-H. Kim, K. Choi, Y.-E. Sung, S.-H. Kang, Nitrogen and boron co-doped hollow carbon catalyst for the oxygen reduction reaction, *Carbon* (2016), doi: 10.1016/j.carbon.2016.04.018.

Nitrogen and boron co-doped hollow carbon catalyst for the oxygen reduction reaction

Ji-Sun Han,[a] Dong Young Chung,[b,c] Dae-Gwon Ha,[a] Jin-Hong Kim,[d] Keunsu Choi,[e] Yung-Eun Sung [b,c] and Shin-Hoo Kang*[a]

[a.] *Department of Materials Science and Engineering, Seoul National University, Seoul 151-742, Republic of Korea.*
[b.] *Center for Nanoparticle Research, Institute for Basic Science (IBS), Seoul 151-742, South Korea.*
[c.] *School of Chemical and Biological Engineering, Seoul National University, Seoul 151-742, South Korea.*
[d.] *Samsung Electronics, 129 Samsung-ro, Maetan-dong Yeongtong-gu, Suwon, Gyeonggi-do 443-742, Republic of Korea.*
[e.] *Computational Science Research Center, Korea Institute of Science and Technology, Hwarang-ro 14-gil 5, Seongbuk-gu, Seoul 136-791, Republic of Korea.*

Abstract

Hollow particles of N,B co-doped carbon were synthesized at different temperatures and used as electrocatalysts for the oxygen reduction reaction (ORR). The particles were synthesized by chlorinating $Ti(C_{0.3}N_{0.7})$ and TiB_2 powders, with the sample formed at 800 °C showing the highest ORR activity, which was comparable to a commercial Pt/C catalyst. The catalyst electron transfer number of 3.94 was close to 4, indicating high selectivity for the ORR. The excellent ORR performance arose from the particle structure that facilitated mass transport, including the hollow shape with well-developed micro and macro pores, and various active nitrogen functional groups on the surface. Boron also played an important role along with the nitrogen, improving the activity for the ORR through a synergistic effect. These properties make these materials promising for the ORR and other electrochemical applications.

1. Introduction

Low density, good interconnectivity, and exposed active sites on the surface make hollow carbon particles promising for nanotechnology

* *Corresponding author.*

E-mail address: shinkang@snu.ac.kr (S. Kang)