Influence of nitrogen-doping in carbon on equivalent distributed resistance and capacitance – Implications to Electrocatalysis of oxygen reduction reaction

Bapi Bera, Tathagata Kar, Arup Chakraborty, Manoj Neergat

PII: S1572-6657(17)30727-0
DOI: doi:10.1016/j.jelechem.2017.10.025
Reference: JEAC 3585

To appear in: *Journal of Electroanalytical Chemistry*

Received date: 20 April 2017
Revised date: 18 September 2017
Accepted date: 10 October 2017

Please cite this article as: Bapi Bera, Tathagata Kar, Arup Chakraborty, Manoj Neergat , Influence of nitrogen-doping in carbon on equivalent distributed resistance and capacitance – Implications to Electrocatalysis of oxygen reduction reaction. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Jeac(2017), doi:10.1016/j.jelechem.2017.10.025

Influence of Nitrogen-doping in Carbon on Equivalent Distributed Resistance and Capacitance – Implications to Electrocatalysis of Oxygen Reduction Reaction

Bapi Bera, Tathagata Kar, Arup Chakraborty, Manoj Neergat*

Department of Energy Science and Engineering, Indian Institute of Technology Bombay (IITB), Powai, Mumbai–400076, India

Abstract

Carbon is heat-treated with nitrogen-containing precursor (ammonia or melamine) to yield N-doped carbon. The nitrogen content in the sample depends on the type of the precursor and the heat-treatment temperature and it is estimated using CHN analysis. The electrochemical impedance spectroscopy (EIS) patterns of the samples recorded in argon-saturated 0.1 M KOH show a high-frequency equivalent distributed resistance (EDR) and a low-frequency capacitive straight line, tilted slightly away from the y-axis. The EDR and the tilt of the capacitive straight line decrease with increase in nitrogen-content in the N-doped carbon samples. Further, EIS of oxygen reduction reaction (ORR) is recorded with carbon and N-doped carbon in oxygen-saturated 0.1 M KOH. The EIS patterns of ORR suggest that the high-frequency EDR feature is not negligible, unlike that with carbon-supported and unsupported Pt catalysts in both acidic and alkaline media. Therefore, nitrogen content and EDR have important implications in deciding the electrocatalytic activity and the features of the EIS patterns of carbon-based metal-free catalysts. Because of the change in EDR and the capacitance with nitrogen-content, the EIS patterns of ORR with N-doped carbon are complex to analyze.

Keywords: electrochemical impedance spectroscopy, equivalent distributed resistance, nitrogen-doped carbon, oxygen reduction reaction, reduced graphene oxide

*Corresponding author. Tel.: +91 22 2576 7893; Fax: +91 22 2576 4890

E-mail address: nmanoj@iitb.ac.in