Ruthenium Based Catalysts/Reduced Graphene Oxide Composite for Air Breathing Electrodes of Lithium-Air Batteries

Yo Sub Jeong[1], Ju Ho Kim[1] and Yun Jung Lee[1]

[1]Department of Energy Engineering, Hanyang University, Seoul, Korea

Correspond to yjlee94@hanyang.ac.kr

The demand for high performance energy storage system for electric vehicles and various types of electronic equipment has constantly increased recently. Lithium-air battery is one of the most promising candidates that satisfy the needs of high performance power sources since it offers theoretical energy density about 10 times higher than that of existing lithium-ion battery system. Li-air battery may reach a practical specific energy density of ~500 Wh kg^{-1}, which is considerably higher compared with 150 Wh kg^{-1} of the state-of-the-art Li-ion batteries.[1-4]

One of the problems that shorten the cycle life of the Li-air cell is the slow kinetic of the oxygen reaction resulting in large overpotentials, especially in the oxygen evolution reaction (OER). Though noble metal nanoparticles are known as oxygen reduction reaction (ORR) electrocatalysts in fuel cells and many other oxidation reactions, it is reported that ORR in Li-air systems is hardly improved by the presence of catalysts other than carbon or carbon itself catalyzes ORR sufficiently in Li-air battery. OER, on the other hand, has been reported to be catalytically sensitive.[5-7]

Herein, we developed reduced graphene oxide (rGO) with ruthenium based nanoparticle catalysts for high performance air breathing electrodes in Li-air batteries. Ru and RuO_2 nanoparticles supported on rGO acted as OER electrocatalysts in Li-air cell cathodes with $LiCF_3SO_3$-TEGDME salt-electrolyte system. These rGO/Ru-based catalyst composites showed superior performances than conventional carbon based air cathodes.

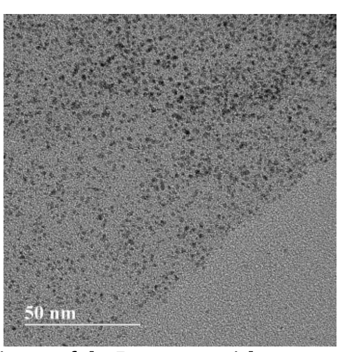

Figure 1. TEM image of the Ru nanoparticles supported on rGO.

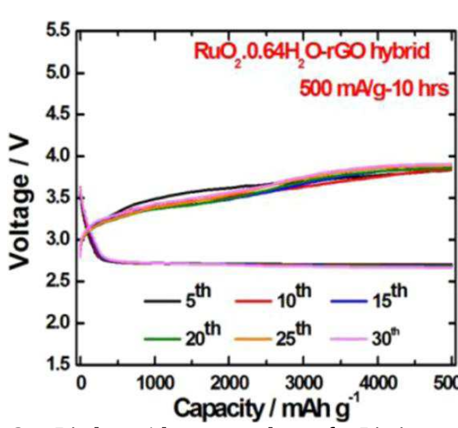

Figure 2. Discharge/charge cycles of Li-air cells using $RuO_2 \cdot 0.64H_2O$-rGO composite.

ACKNOWLEDGEMENT

This work was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (grant no.2012R1A1A1009029 and 2012R1A1A2021678).

REFERENCES

[1]P. G. Bruce, S. A. Freunberger, L. J. Hardwick, J.-M. Tarascon, Nature Materials **2012**, 11, 19.
[2]J. Christensen, P. Albertus, R. S. Sanchez-Carrera, T. Lohmann, B. Kozinsky, R. Liedtke, J. Ahmed, A. Kojic, Journal of the Electrochemical Society **2012**, 159, R1.
[3]B. Scrosati, J. Garche, Journal of Power Sources **2010**, 195, 2419.
[4]B. Scrosati, J. Hassoun, Y. K. Sun, Energy & Environmental Science **2011**, 4, 3287.
[5]Winter, M.;Brodd,R.J. chemical Reviews**2004**,104,4245.
[6]Gu, Y.J.; Wong, W.T journal of the Electrochemical Society **2006**, 153, A1714
[7]Lu, Y.-C.;Gasteiger, H. A; Shao-Hom, Y. journal of the American Chemical Society**2011**,133,19048