

Composite graphene/MnO₂ as catalyst for air electrodes in metal-air batteries

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Abstract

Metal-air batteries have the potential to store more energy than lithium-ion batteries with a relative lower cost, simplicity and without the lithium safety concerns. The performance of this battery is mainly determined by the oxygen reduction reaction (ORR) at the air cathode, and a considerable effort has been dedicated to develop new air electrodes composed by an ORR catalyst supported in an electrical conductive material (e.g. carbon based materials) [1].

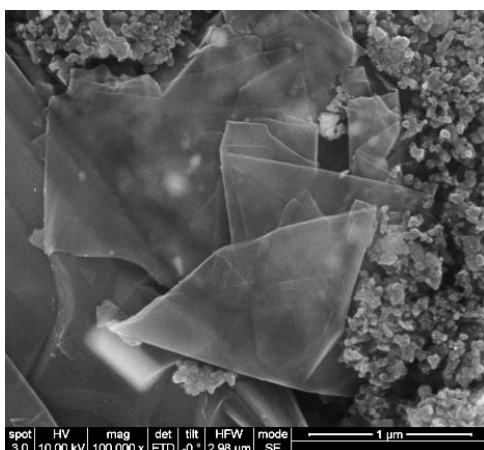
Transition metal oxides have been proved as good catalysts for the ORR in alkaline media, replacing the expensive noble metals (e.g. platinum). In particular, MnO₂ presents a high catalytic activity, specific capacitance and it is inexpensive, abundant and environmentally friendly. On the other hand, graphene is an advantageous support material to replace conventional carbon materials in air electrodes. The combination of high surface area, elevated mobility of charge carriers, high conductivity, unique graphitized basal plane structure and potential low manufacturing cost makes graphene a promising candidate to be used in this application. Additionally, an improvement in the ORR catalytic activity has been demonstrated with the synergetic interaction of graphene and the metal-oxide [2].

In this work, we present the study of a MnO₂/graphene catalyst, synthesized by a simple in-situ hydrothermal method [3] that leads to an uniform distribution of the metal oxide particles over the graphene platelets. X-ray diffraction (XRD) analysis shows an amorphous structure for the manganese oxide, which can increase its catalytic activity due to the high concentration of lattice defects and active sites in the material. The electrochemical characterization of this MnO₂/graphene composite catalyst includes the evaluation of the ORR activity using the rotating disc electrode (RDE) technique in KOH 1M at 25 °C. Promising results have been achieved, demonstrating that the ORR follows the 4e⁻ pathway and with an activation overpotential only 80mV greater than the Pt/C used as reference.

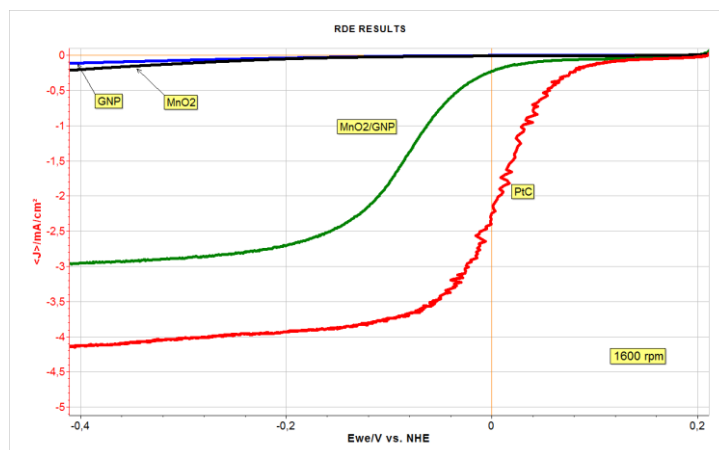
References

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- [2] Y. Liang, Y. Li, H. Wang, J. Zhou, J. Wang, T. Regier and H. Dai, Nature Materials, 10 (2011) 780.
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Figures



SEM micrograph of MnO₂/graphene composite catalyst



Linear sweep voltammograms (LSV), at 1600 rpm rotating rate, comparing MnO₂/graphene sample with Pt/C catalyst