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Citation	
Issue Date	2024-03
Type	Thesis or Dissertation
Text version	ETD
URL	http://hdl.handle.net/10119/19078
Rights	
Description	supervisor: 松見 紀佳, 先端科学技術研究科, 博士

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Bifunctional Pt/Ir nano-particles decorated functionalized acetylene black and its application in Li-air batteries
(Pt/Ir ナノ粒子を修飾したデュアル機能剝離アセチレンブラックのリチウム空気電池への応用)

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Li-air batteries offer superior energy density compared to traditional Li-ion batteries , aligning with the global shift toward sustainable electric vehicles. The cathodic efficiency crucially hinges on the oxygen reduction reaction (ORR), for which platinum supported on carbon (Pt/C) has been a prevalent catalyst. However, the challenge in Li-air batteries lies in the simultaneous requirement for oxygen evolution reaction (OER) alongside ORR. This predicament has spurred investigations into amalgamating Pt with high OER activity metals like Ir, Co, and Fe. Despite their promising performance, the stability and potential leaching of these catalysts remain significant challenges [1].

This study exploits a carbon substrate demonstrating strong metal substrate interaction (SMSI) for heightened electrocatalytic durability. Building upon prior work [2], a novel functionalized acetylene black (Pt-FAB) was introduced, exhibiting remarkable catalytic activity due to efficient interfacial interactions with nanoparticles and electrolyte. The current study augments OER activity by incorporating Ir into the Pt-FAB catalyst. This unique Pt-Ir/FAB combination is anticipated to offer both high activity and durability, owing to efficient interfacial properties [3].

Acetylene Black (AB) is treated with a mixed strong acids to improve dispersion in water or organic solutions, enabling the formation of a catalyst with multiple functions. ORR and OER experiments are performed in an organic electrolyte, using TEGDME with 0.1 M LiFSI or LiTFSI. The next step involves constructing a Li-air battery, where a cathode slurry with active materials is coated on a carbon cloth. The electrolyte, consisting of 0.1 M LiI and 1 M LiTFSI in TEGDME, is used, and the battery operates under a 99.9% oxygen atmosphere at 0.1 MPa. The capacity is limited to 1000 mAh/gPt-Ir at charge-discharge rates of 125 mA/g and 250 mA/g to evaluate the material's long cycle life.

Acetylene Black (AB) treated with mixed strong acids enhances dispersion, which is crucial for forming a catalyst with controlled size and distribution. This work introduces a pioneering bimetallic Pt-Ir catalyst on functionalized acetylene black (FAB) for Li-air batteries. FAB, modified with -COOH functional groups, serves as a stable substrate for metal nanoparticle deposition. X-ray photoelectron spectroscopy (XPS) confirms successful Pt^0 and Ir^{4+} deposition on FAB. Electrochemical measurements reveal satistactory activities in ORR and OER, sustaining over 250 cycles in organic electrolytes. Cyclic voltammetry underscores its potential for Li-air battery. FAB180-Pt/Ir 1:1 with a 1000 mAh/g charge-discharge capacity maintained constant performance over 70 cycles, showcasing outstanding OER and ORR activity.

Bibliography

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Keywords: Oxygen reduction reaction, Oxygen evolution reaction, Dual electrocatalysts, Li air batteries, Rechargeable battery