Nature Derived Carbon Microsheets as Efficient Electrocatalyst for Energy Storage

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Light-weight metal-air batteries have drawn much attention particularly in the transportation industry. Rechargeable Zn-air batteries, with six times larger energy density compared to Lit-ion batteries and theoretical specific energy of 1086 Wh kg-1 (c.a. 387 Wh kg-1 for Li-ion), is a strong candidate to meet the growing energy storage demands of this industry. However, the lack of efficient oxygen electrode catalysts of high stability and low cost in Zn-air batteries remains a significant problem. This project presents a novel natural oxygen reduction reaction (ORR) catalyst derived entirely from eggplant (Solanum melongena L.). Scanning electron microscopy revealed a microsheet-like morphology for carbonized eggplant (EPC). Through electrochemical experimentation, EPC was found to have an unexpected ORR activity: upon activation with KOH, the ORR activity improved to be comparable to carbon supported nano-sized platinum (Pt/C), one of the most efficient commercialized electrocatalysts available today. More remarkably, activated carbonized eggplant (AEPC-900) outperformed Pt/C in stability tests done in the realistic operation environment of a single-cell setup. Such improvement in performance was attributed to a 100-fold increase in the specific surface area of EPC, which is believed to be a result of pore generation in the carbon sheets by the activation treatment. Considering that carbonization and activation are the only main steps required for material preparation and that eggplant can be derived from nature, AEPC-900 is simple to produce, low cost and environmentally-friendly. This proof-of-concept exploration showed that AEPC-900 can serve as a metal-free ORR catalyst which can be further developed to improve Zn-air battery performance.

Awards Won:

Intel ISEF Best of Category Award of $5,000

First Award of $5,000