Development of ultra-high capacity lithium-air batteries using CNT sheet air electrodes

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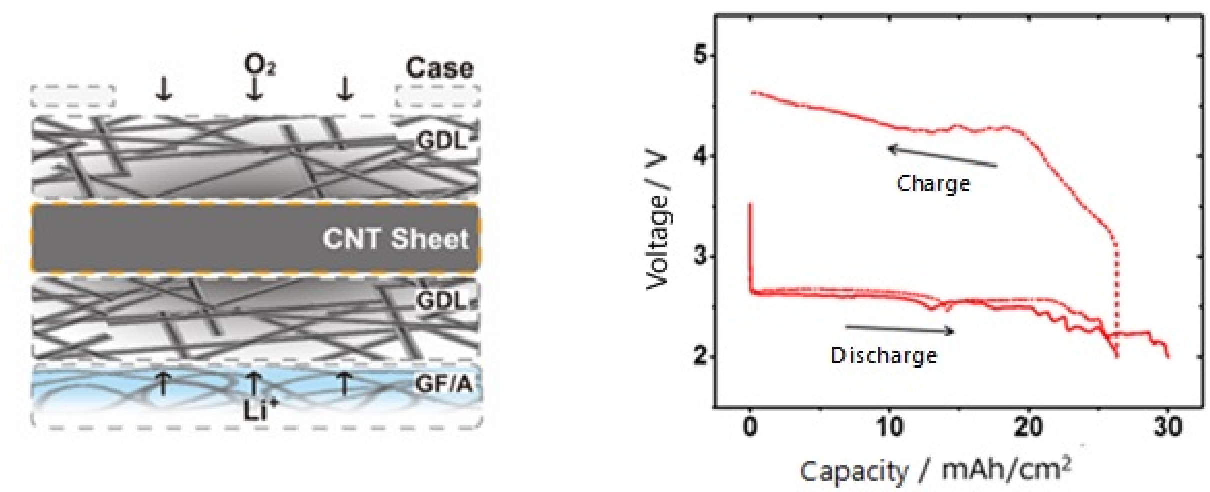

Conceptual diagram of a CNT sheet air electrode (left) and charge-discharge characteristics of the lithium-air battery with ultra-high capacity (right). Credit: National Institute for Materials Science (NIMS)

A NIMS research team led by Yoshimi Kubo and Akihiro Nomura has developed lithium-air batteries with electric storage capacity 15 times greater than the capacity of conventional lithium-ion batteries using carbon nanotubes (CNT) as an air electrode material.

Demand for rechargeable batteries is expected to increase rapidly as electric vehicle power sources and joint sources of household electricity with solar cells. The current lithium-ion batteries have advantages of compactness, high voltages, and long life, but their energy densities, which represent electric storage capacities, have nearly reached their limit. Lithium-air batteries have great potential in overcoming this issue. The lithium-air battery would be the highest energy density in theory. The battery as theorized may have drastically large capacity and reduce production costs. However, conventional battery research usually focuses on basic studies of battery reactions using small amounts of materials, and therefore is not designed to demonstrate large battery capacities using cells of actual size and shape.

The research team recently achieved very high electric storage capacity of 30 mAh/cm2 using realistic cell forms. This value represents about 15 times greater capacity compared to the capacity of conventional lithium-ion batteries (about 2 mAh/cm2). This achievement was made by using CNTs as an air electrode material, thereby optimizing the electrode's microstructure. The researchers think that the battery's large capacity can be attributed to CNTs' large surface area and flexible structure. It is unlikely that existing knowledge can explain the capacity increase seen in this study, and these findings may stimulate discussion over lithium-air battery reaction mechanisms.

In light of these results, the scientists aim to develop practical, high-capacity lithium-air batteries by exploring techniques to increase energy density in cell layer stacks, and removing impurities from the air.

More information: Akihiro Nomura et al. CNT Sheet Air Electrode for the Development of Ultra-High Cell Capacity in Lithium-Air Batteries, *Scientific Reports* (2017). DOI: 10.1038/srep45596

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