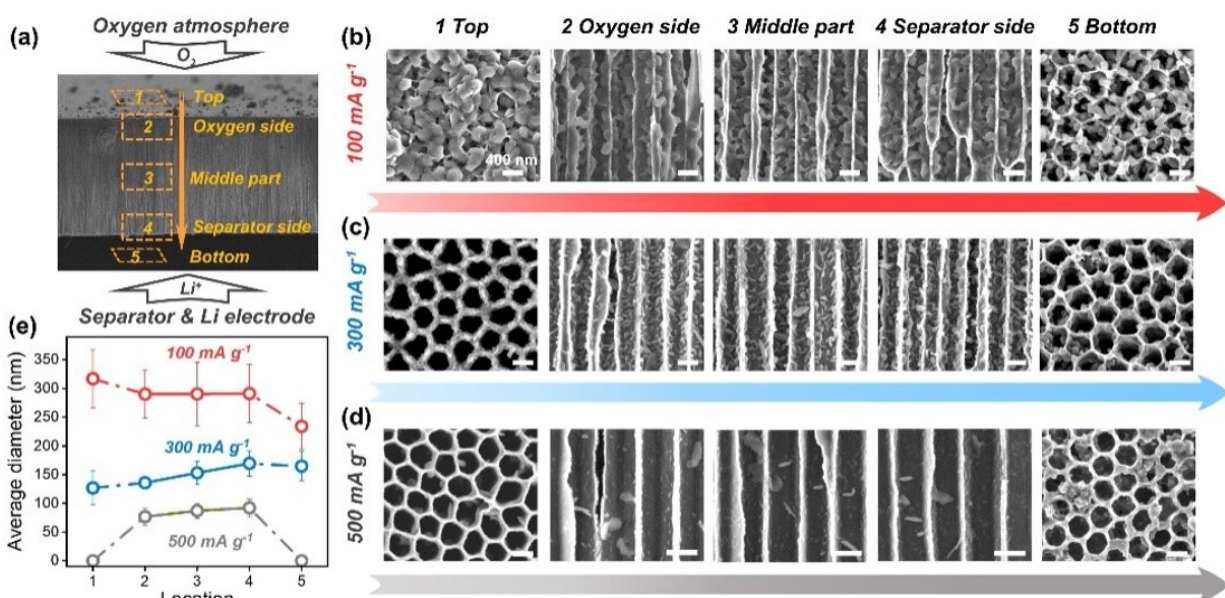


Researchers unveil mystery inside lithium oxygen batteries

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The distributions and sizes of lithium peroxide on the end surfaces of C-AAO electrodes and inside them. Credit: Prof. TAN Peng's team

With a high energy density, Li-O₂ batteries have become a state-of-the-art battery technology. Inside the Li-O₂ battery, the generation and disintegration of the discharged product solid lithium peroxide (Li₂O₂) have a significant effect on the battery's performance. Previous research has shed little light on Li₂O₂ 's form and distribution inside, leaving questions regarding the trend and contributing factor of internal Li₂O₂ 's

change in form and size unanswered.

Recently, a team led by Prof. Tan Peng from the University of Science and Technology of China (USTC) of the Chinese Academy of Sciences designed a carbon-coated anodic aluminum oxide (C-AAO) air electrode with a highly-ordered, array-like structure. The team gained new insights into the [sudden death](#) and reaction routes of Li-O₂ batteries. The work was published in *Nano Letters*.

The research team designed a special C-AAO electrode that breaks easily yet preserves its distribution of products, enabling Li₂O₂ observations throughout the entire electrode. Using electrochemical impedance spectroscopy (EIS), the team determined the contributing factor to sudden voltage drop and death at various current densities.

Research findings show that, at small currents, channel diameters restrict the growth of toroidal Li₂O₂, causing electrode blockage. So the sudden death in voltage is associated with a large charge transfer impedance and concentration polarization caused by electrode blockage. While at high currents, the sudden death is attributed to the less significant charge transfer impedance and concentration polarization from the fast electrochemical reactions.

Additionally, in order to find the mechanism of such reactions, the research team carried out detailed analysis on the growth model of Li₂O₂ on the end surfaces and the interior of C-AAO electrodes. Li₂O₂ on the end surfaces is found in three toroidal model.

The most common one grows "hugging" the wall, forming an incomplete ring. The rest either grows laterally on the [surface](#), or in the form of nuclei, forming on other Li₂O₂ surfaces. As current density amplifies, toroidal Li₂O₂ inside the electrode is likely to be covered by its flocculated counterparts, indicating that Li₂O₂ is produced along the

surfaces of the electrode, rather than from disproportionation inside channels.

The team proposed a new growth route for toroidal Li_2O_2 , in which Li_2O_2 formed at the Li_2O_2 /[electrode](#) interface during early growth is related to the surface route, followed by lithium peroxide (LiO_2) in solution disproportionating around Li_2O_2 particles, covering the surface route and forming an incomplete ring.

This research provided answers to long-standing questions regarding the mechanism of Li- O_2 batteries, as well as insights into further electrodes design.

More information: Zhuojun Zhang et al, Reacquainting the Sudden-Death and Reaction Routes of Li- O_2 Batteries by Ex Situ Observation of Li_2O_2 Distribution Inside a Highly Ordered Air Electrode, *Nano Letters* (2022). [DOI: 10.1021/acs.nanolett.2c02516](https://doi.org/10.1021/acs.nanolett.2c02516)

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