Visualization of O_2 on Aqueous Li-air Battery by Using Microfocus X-ray CT

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The reaction products associated with charge/discharge processes are key issues to improve the performance of Li-air battery [1]. In previous researches, LiO_2, Li_2O_2 and other Li organic compounds were investigated; however, production of O_2 in charge process that causes reduction of electrode area has not studied. In this study, experimental visualization of the inside of air cathode was realized by employing a microfocus X-ray computed tomography (CT), and production of O_2 in aqueous electrolyte by the charge reaction has been successfully visualized.

Employed microfocus X-ray CT, inspeXio SMX-225CT (Shimadzu Co., Ltd., Tokyo, Japan), and schematic image of Li-air battery are shown in Fig. 1 and Fig. 2, respectively. The Li-air battery is constructed of a lithium-metal active layer, a lithium-ion conducting polymer buffer-layer (PEO), a water-stable LTAP (NASICON-type glass ceramic) protective layer, filter paper (LiCl electrolyte was impregnated), and a carbon air cathode [2, 3]. In order to obtain clear CT image, carbon paper was used as current collector, because metallic electrode causes metal artifact. Three-dimensional CT images that indicate density (material) distribution were reconstructed and slice images at the contact face of hydrophilic filter paper/hydrophobic carbon paper was obtained. Evaporation of electrolyte was reduced by performing the whole experiment within a short time at room temperature (–25C°) .

Experimental results are given in Fig. 3. Compare to each image, change in density can be observed. The filter paper at the initial condition was fully saturated by LiCl electrolyte. On the discharge process, the reaction area remained saturated by electrolyte; however, significant change was observed after charge process. Emergence of dark gray area indicates gas generation, and thus it suggests production of O_2 in air cathode. Although the produced gas surrounded most part of reaction area, there were also still electrolyte saturated region. It is considered that area ratio between gas and electrolyte strongly affects the battery performance on charge process.

References

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[2] T. Zhang, N. Imanishi, Y. Shimonishi, A. Hirano, Y. Takeda, O. Yamamoto, *Chem. Commun.*, 2010, **46**, pp 1661-1663.
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Figure 1 Microfocus X-ray CT.

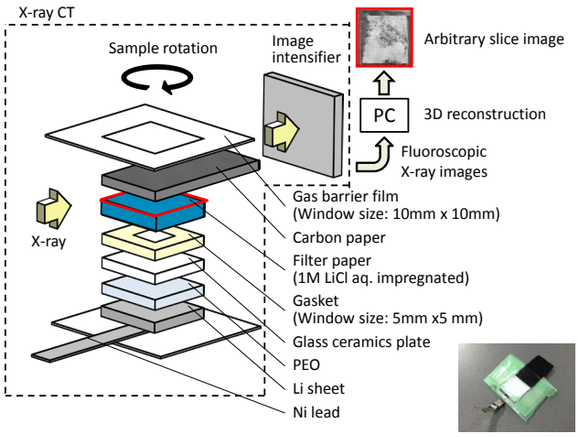
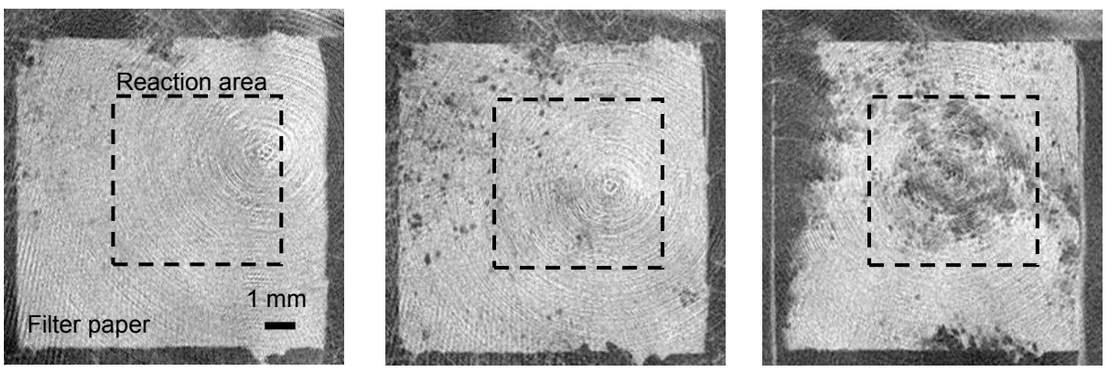


Figure 2 Schematic image of Li-air battery and X-ray CT observation system).



(a) Initial condition
(b) After 30 min discharge (0.16–0.02 mA/cm^2)
(c) After 15 min charge (4.0V, 0.01 mA/cm^2)

Figure 3 Slice image of filter paper. Slice thickness was 43 μm. Light gray part and dark gray part indicate LiCl aq. and gas phase, respectively. Enclosed area in dashed line indicates reaction area (5mm×5mm).