

Reactions in the Rechargeable Lithium-Air Battery with Ether based Electrolytes

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Because of their ultra-high energy densities, lithium-air batteries are promising candidates for a variety of applications including electric vehicles (EVs). However, there are still many challenges to overcome for the development of a practical rechargeable lithium-air battery. Electrolyte stability is one of the key criteria to improve the performance of the lithium-air batteries.

It has been demonstrated that conventional organic carbonate electrolytes decompose on discharge and no evidence of reversible oxygen reduction to Li_2O_2 has been found.^[1,2] Ethers are attractive solvents because they are more stable than carbonates.^[3] The reaction mechanism of the lithium-air battery in ethers has been investigated using in situ mass spectroscopy (MS). The cell consisted of a metallic lithium foil anode, a Celgard separator and a cathode. The air electrode was composed of a mixture of Super P carbon and Teflon coated on a carbon cloth and the electrolyte was 0.7 M lithium bis(trifluoromethanesulfonyl)imide (LiTFSI) in tetraethylene glycol dimethyl ether (TEGDME). Experimental setup is shown in Fig. 1.

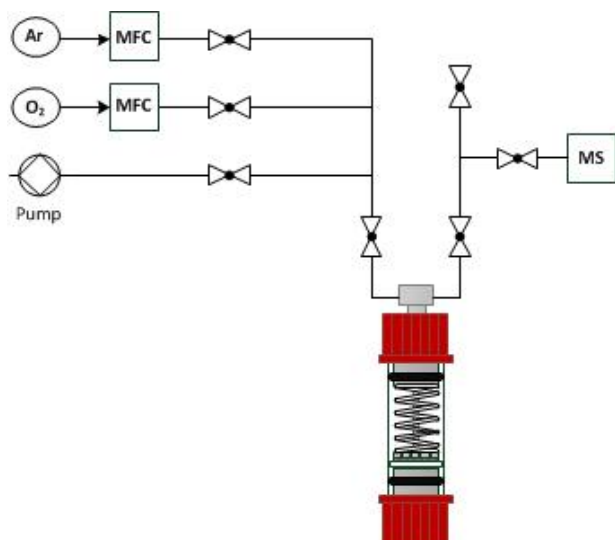


Fig. 1: Setup used for the MS measurements. MFC: mass flow controller.

The mass spectroscopy allowed the measurement of the CO_2 (m/z 22) and O_2 (m/z 32) evolved during charging. No significant increase of CO_2 was observed until 3.7 V vs. Li/Li^+ (Fig. 2). Above this potential, CO_2 was formed due to electrolyte decomposition. Methoxyethane, methoxyethene and dimethoxyethene have been analysed as possible reaction products thanks to other mass fragments. Oxygen was also released during charging. The influence of the catalyst on the gas composition has been investigated and will be presented.

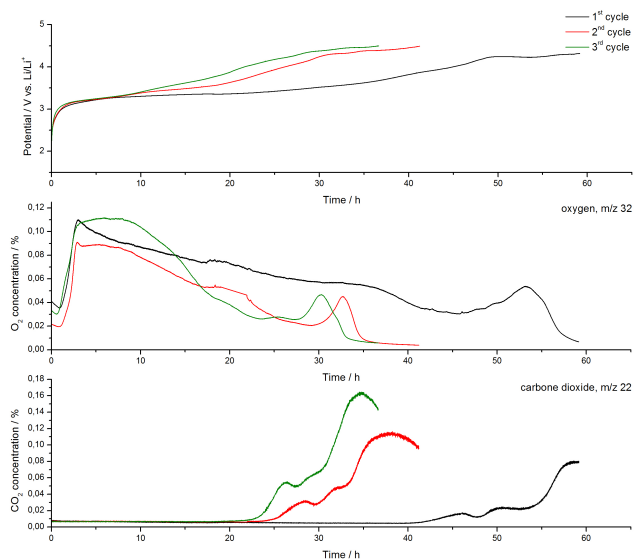


Fig. 2: O_2 and CO_2 evolution during the first charging processes of an air electrode with catalyst ($\alpha\text{-MnO}_2$). Rate: 0.1 mA/cm^2 .

The cycle life results confirm the good reversibility of the reaction. With TEGDME as electrolyte, a very good capacity retention has been obtained (Fig.3).

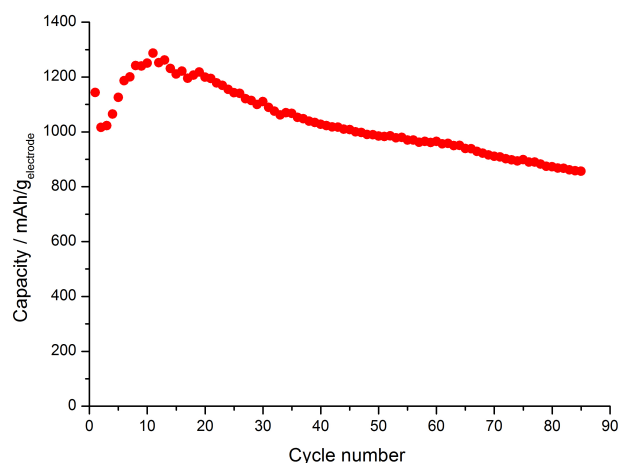


Fig. 3: Variation of the discharge capacity in $\text{mAh/g}_{\text{electrode}}$ (carbon + catalyst + binder) with cycle number at a rate of 0.1 mA/cm^2 .

References:

- [1] W. Xu, J. Power Sources **2011**, 196, 9631-9639.
- [2] S. A. Freunberger, J. Am. Chem. Soc. **2011**, 133, 8040-8047.
- [3] H.-G. Jung, Nat. Chem. **2012**, 4, 579-585.