Effects of an Organic Electrolyte Additive on the Stability of Lithium Metal Anode for Rechargeable Batteries

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Lithium (Li) metal has attracted much attention as an anode material for high performance batteries due to its high capacity and lowest standard red-ox potential. However, Li metal is thermodynamically unstable in organic electrolytes: it reacts with the electrolytes to form a solid electrolyte interface (SEI) layer. This layer can prevent the direct contact between Li metal and liquid electrolyte and further decomposition of the electrolyte, once the stable SEI layer forms. Nevertheless, the non-uniform chemical composition of the SEI layer can induce an uneven current distribution on the Li surface, which is responsible for the growth of Li dendrite and the resultant electric short circuit. Thus far, approaches to prevent Li dendrite have focused on improving the stability and uniformity of the SEI layer formed on the Li surface by adjusting electrolyte components and including electrolyte additives.

In the present study, we suggest the use of an electrolyte additive for suppressing the growth of Li dendrite by forming uniform and stable SEI layer on Li surface. The base electrolyte of 1 M LiTFSI in TEGDME was used for tests. The Li symmetric cell containing the electrolyte additive was galvanostatically cycled over 300 cycles for each charge and discharge time of 2 h at a current density 1 mA cm^{-2}, which was >30 times longer than that of the Li symmetric cell without additive in electrolyte. This electrolyte additive helps to make a stable and uniform SEI layer, leading to effectively suppressing the growth of Li dendrite. Further, the electrolyte additive can be used in the Li metal based batteries such as a Li-O_2 battery. The Li-O_2 cell containing the additive was cycled for longer than 200 cycles at a current density of 0.1 mA cm^{-2} under a limited capacity mode of 1000 mAh g^{-1}, which was >4 times longer than that of the Li-O_2 cell without the additive in electrolyte. This electrolyte additive improved the electrochemical performance, especially cyclability of Li-O_2 batteries.