Novel materials for anode-free lithium metal batteries

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Anode-free lithium metal batteries have gained attention in the electrochemical community due to their enhanced safety, cost-effectiveness and higher energy density compared to the Lithium-Ion Batteries. In fact, an anode-free battery employs only a current collector as an anode, where Li metal can be continuously plated and stripped. While charging, lithium ions, extracted from the cathode, are electrodeposited on the current collector (usually copper) and then, the lithium metal plated is dissolved and intercalated again into the cathode during the discharge step. The absence of an active material on the anode side leads to a reduction in the weight and the thickness of the full cell, boosting the gravimetric and volumetric energy density. Nevertheless stripping-deposition of lithium ions on the current collector suffers from significant deactivation phenomena respect to the intercalation materials. Dendrites growth and loss of active material ("dead lithium") are the main causes of the limited reversibility of these devices [1]. In this scenario two of the most promising state of art strategies to mitigate the lithium chemistry are: 1) the development of an appropriate artificial Solid Electrolyte Interphase (a-SEI) [2] that could mechanically resist to the lithium growth forcing the formation of homogeneous lithium layers on the current collector. 2) the use of a current collector with Laser-Induced Periodic Surface Structures (LIPSS) [3], in order to provide lithium ions favorable nucleation sites avoiding dendritic growth. In this communication, we will thus show some preliminary results about the effects of these two different approaches in a full anode-free lithium metal battery. We demonstrated the beneficial effects of an a-SEI based on polyethylene oxide (PEO) and a nanostructured collector, using lithium iron phosphate as a cathode material.

References

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