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The rechargeable Li-air ($Li-O_2$) battery has attracted attention in recent years due to its high theoretical energy density. However, several obstacles including the instability of electrolyte solvents and salts, poor rate capability, lithium dendrite formation, safety issues, etc have hampered the development of the Li-air battery.[1]

I) Degradation of electrolyte solvents and salts

During cycling of Li-air cells in non-aqueous electrolytes, the oxygen reduction and oxygen evolution reactions (ORR and OER) take place in the cathode during the discharge and charge, respectively. Lithium superoxide and lithium peroxide (LiO_2 and Li_2O_2) as the intermediate and final discharge reaction products form in the cell. However, it has been shown that ORR and OER result in decomposition of aprotic carbonate and ether based electrolytes. Also, ORR and OER decompose most common Li salts like $LiPF_6$, $LiBF_4$, LiTFSI, $LiClO_4$, and LiBOB.[2]

Furthermore, Li_2O_2 as the final discharge product is very reactive, and therefore, it can degrade electrolyte solvents and salts. It has been revealed that carbonate, ether, and dimethyl sulfoxide solvents as well as common Li salts such as $LiPF_6$, $LiClO_4$ and $LiBF_4$ decompose in contact with Li_2O_2, and consequently, form degradation products on the surface of Li_2O_2.[2,3]

II) Issues regarding utilization of Li metal

A proper electrolyte needs to be compatible with lithium metal anode in the Li-air battery. Owing to its very negative potential, lithium metal decomposes aprotic electrolytes as soon as its surface is exposed to electrolyte. As a consequent, a solid electrolyte interphase (SEI) can be formed on the surface on Li metal. This electrode/electrolyte interphase should be stable during cell cycling to protect electrolyte from further decomposition. However, it has been shown that the SEI on Li anode in the presence of oxygen evolves.[2]

Thus, poor performance of SEI on Li anode results in i) dendrite formation, and ii) low columbic efficiency. Therefore, these challenges regarding the utilization of Li metal anode should be investigated carefully. The dendrite formation can ultimately cause an internal short circuit, which produces local heating, often leading to fire. This issue could be hindered by different approaches like using solid membrane, improving cell design, etc. The columbic efficiency of Li plating/stripping on Li anode is significantly influenced by electrolyte solvents and salts as well as by electrolyte additives. The columbic efficiency of Li anode should be improved by using tuning electrolyte chemistry for designing a functional Li anode.

References

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