Significantly Improving the Durability of Gel Polymer Electrolyte Based Lithium-air Batteries

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Lithium-air batteries with extremely high theoretical energy density are a promising candidate for next generation energy storage system. However, their practical application faces great challenges including the bad electrochemical reversibility [1], which is mainly attributed to the volatilization and decomposition of the electrolyte, the slow reaction kinetics of discharge product and the gradually blocked cathode, besides the metal lithium anode issues.
In view of the above issues of the electrolyte, gel polymer electrolyte (GPE) should be a good choice since the polymer chains swell in the aprotic electrolyte, which contributes to lowering vapor pressure and increasing stability of the electrolyte system. In our previous work, the novel polyvinyl formal (PVFM) based membrane supporting GPE has been developed to be one of attractive electrolyte for lithium-ion batteries, possessing a high liquid uptake, a good conductivity of 10^{-3} S cm^{-1}, a wide electrochemical window up to 5.0 V[2]. Even so, the stability against attack by superoxide radical and the accommodated space for the discharge products are still questionable, especially the interface between cathode and electrolyte becomes much more crucial in polymer electrolyte based Li-O_2 batteries.
In the work, a novel assistant cathode membrane (ACM), which was prepared via coating multi walled carbon nanotubes (MWCNTs) on one side of polyvinyl formal (PVFM) based membrane, has been developed to enhance electrochemical reversibility of Li-O_2 batteries. ACM-supporting GPE possesses a specific morphology, an impressive electrolyte retainability and a high ionic conductivity of 1.01×10^{-3} S cm^{-1} with the optimized solvent component. Especially, the side with MWCNTs coating keeps an intimate contact with cathode, not only assisting the cathode to preserve the electrolyte infiltrating interface and three-phase boundary, but also producing the conductive pathway and accommodation space for discharge products. The ACM-containing batteries demonstrates a long-time circulation as shown in Fig.1, i.e. 130 times at the current density of 100 Ah g^{-1} (0.1 C) and 80 times at 0.2 C with 1000 mAh g^{-1} capacity limitation, and an excellent rate performance up to 5 C.

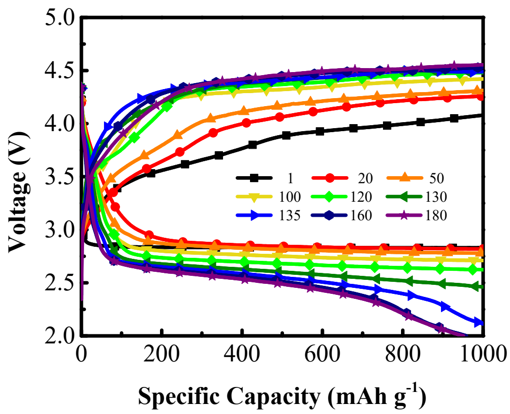

Fig.1 Voltage profiles of the Li-O_2 battery with the ACM-supporting GPE

References:
[1] P. G. Bruce, S. A. Freunberger, L. J. Hardwick, J.-M. Tarascon, Nature materials. 11(2012)19-23.
[2]F. Lian, Y. Wen, Y. Ren, H. Guan, J. Mem. Sci. 456 (2014) 42-48.