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METAL-ORGANIC FRAMEWORK FOR STABLE CYCLABILITY OF LI-S BATTERIES FOR SPACE MISSIONS

Abstract

High reliability of satellite components in Earth orbit is an essential requirement due to costly replacement of new satellite. One of the key components is the battery that delivers electric power. Space missions require batteries with high energy density, specific energy, efficiency, light-weight, wide temperature range and long shelf-life [1]. Energy density of lithium-ion batteries have proven as insufficient in the space industry. Lithium-sulfur (Li-S) batteries with theoretical specific energy of 2600 Wh/kg are among the promising candidates that could replace these batteries. Furthermore, theoretical capacity of sulfur is 1675 mAh/g and sulfur resources are an abundant, which results in a low cost and environmental friendliness. The commercial application of Li-S batteries is hindered by several challenges. One of the main problems is shuttle effect of lithium polysulfides and the consequence in loss of active material and capacity fading. Another challenge is volumetric expansion ($\sim$ 80 %) during charging which may negatively affect the cathode structure. Metal-organic framework (MOF) materials have a unique structure and high porosity which can capture and confine sulfur to predict shuttle effect [2].
In this contribution, porous MOF GdBTC (gadolinium(II)-benzene-1,3,5-tricarboxylate) material was applied as a host for sulfur in Li-S batteries. The electrode slurry consisted of 60 % sulfur, 12 % GdBTC, 12 % carbon Super P, 6 % MWCNTs and 10 % PVDF (polyvinylidene fluoride). The slurry was coated on aluminum foil with carbon modification, electrodes were dries and pressed using a pressure of 350 kg/cm^2

and the sulfur loading was around 2.1 mg/cm^2. The electrolyte in the composition of DME (1,2-Dimethoxyethane):DOL (1,3-Dioxolane) 2:1 with 0.7 M LiTFSI (Lithium bis(trifluoromethanesulfonyl)imide) + 0.25 M LiNO3 (Lithium nitrate) was impregnated into the glass fiber separator and pure lithium was used as a anode. Electrochemical investigation of the prepared electrode was realized using galvanostatic cycling at 0.2 C, 0.5 C, 1 C and 2 C. The initial discharge capacity at 0.2 C was more than 730 mAh/g and after 50 cycles the capacity increased almost up to 800 mAh/g.

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References

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