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DEVELOPMENT OF HIGH-POWER LITHIUM-SULFUR BATTERIES FOR SPACE MISSIONS

Abstract

The essential requirement for the satellite components is high reliability due to the high cost of replacing a new satellite. Space missions during the eclipse are powered by batteries which directly determine the lifetime and functions of the spacecraft. The batteries should provide high power, energy density, Coulombic efficiency, light-weight, and wide temperature range of operation. Lithium-ion (Li-ion) batteries are the preferred power source in space missions due to their high performance and stability [1,2]. Li-ion batteries have completed many spaceflights, proving that the technology is well matured. However, many space missions require batteries with even higher energy density, which Li-ion batteries provide. Lithium-sulfur (Li-S) batteries are likely to be the next generation of energy storage to replace them.

The main advantage of Li-S technology is its theoretical energy density which is approximately five times higher than that of Li-ion cells. In addition, sulfur is an abundant element and environmentally benign. The main obstacle to the successful commercialization of Li-S battery cells is dissolution of polysulfide intermediates and their shuttling between electrodes. This phenomenon results in loss of active material, rapid capacity loss, low efficiency, and high self-discharge rate. Sulfur changes its density during charging, leading to a volume expansion of up to 80

Herein, MOF-74(Ni) was proposed as a support for sulfur in cathode material for Li-S batteries. MOF-74(Ni) is a honeycomb-like material formed by the combination of divalent metal ions and 2,5-dihydroxyterephthalic acid. The sulfur-based electrode material containing MOF-74(Ni) showed a capacity of around 500 mAh/g and low capacity decay despite 100 cycles at 0.5 C. The cycling of the cell at the temperature of 50C increased the specific capacity to 600 mAh/g, however, the capacity fade was more significant compared to room cycling at room temperature.

References
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[3] Z. Cong et al., Journal of Alloys and Compounds, 924 (2022) 166486.