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

Abstract

The essential requirement for the satellite components is high dependability due to expensive replacement of new satellite. Space missions during the eclipse are powered by batteries which directly determine the service life and functions of spacecraft. The batteries should possess high power, energy density, Coulombic efficiency, light-weight, and wide temperature operation range. The preferred energy source in space missions are lithium-ion (Li-ion) batteries due to their high power, energy density, and Coulombic efficiency [1,2]. Li-ion batteries have already completed many space flights, proving that the technology is mature. However, many space missions require batteries with even higher energy density that is provided by Li-ion batteries. Lithium-sulfur (Li-S) batteries are probably going 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. Moreover, sulfur is an abundant element and environmentally friendly. The major obstacle to the successful application of Li-S battery cells is dissolution of polysulfide intermediates and their shuttling between electrodes. The consequence of this phenomenon is loss of active material, fast capacity decay, low efficiency, and high self-discharge rate. Sulfur during charging changes its density resulting in volumetric expansion up to 80 % which may negatively affect the cathode material. Highly porous supporting materials for sulfur may suppress the influence of negative issues. Metal-organic framework (MOF) materials represent a novel class of materials with unique porous structure for sulfur confinement [3].

Herein, MOF-74 was proposed as a support for sulfur in cathode material for Li-S batteries. MOF-74 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 showed low capacity decay despite 100 cycles at 0.5 C.

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