Li-sulfur battery: The effect of morphology engineering and additives on the electrochemical performance

Markéta ZUKALOVA - *The Czech Academy of Sciences, Czech Republic*

Li-sulfur batteries are attractive due to their theoretical capacity of 1677 mAh/g. In addition, sulfur is cheap, environmentally friendly, and abundant. However, despite the long-term effort of researchers, there are still issues to be solved before their commercialization. These issues are related to the dissolution of lithium polysulfides (PS) in liquid electrolyte and their parasitic reactions with the lithium anode and electrolyte components resulting in short cycle life, low cycling efficiency, poor safety, and a high self-discharge rate. Non-conductivity of sulfur requires the incorporation of electron-conductive additive and volume changes accompanying PS formation represent a challenge for cathode architecture. The use of various types of conductive carbons with different porosity led to higher conductivity and enhanced polysulfide-trapping capability increasing the lifetime and specific capacity of Li-S batteries. The use of metal oxide additives with strong PS adsorption performance further improves the performance of Li-S batteries.

In our work, we studied the effect of the morphology of the carbonaceous additive on the charge capacity and cycling stability of the Li-sulfur battery. We found that the external surface area of activated carbon represents the decisive parameter for the performance of the carbon/sulfur composite cathode. Additional TiO_2 top layer on the carbon/sulfur composite cathode increases substantially charge capacity and cycling stability of the Li-sulfur battery due to effective PS localization in the cathode compartment of the battery. In addition, TiO_2 exhibits inherent electrochemical activity for sulfur reduction at potentials negative to Vfb. The impregnation of a glass microfiber separator with TiO_2 further hinders the diffusion of PS to the anode compartment of the battery and improves the electrochemical performance of the sulfur composite cathode. The composite cathode containing mesoporous carbon with a large external surface area, and an additional TiO_2 top layer in the Li-sulfur battery with TiO_2 modified separator provided a charge capacity of 1427 mAh/g, which represents a 75% increase as compared to the system without the top layer and modified separator.