High-Performance Graphene/Sulphur Electrodes For Flexible Li-Ion Batteries Using the Low-Temperature Spraying Method

Lung-Hao Hu a, Pushpendra Kumar b, Feng-Yu Wu c, Syed Ali Abbas b, Chia-Nan Lin d, Jason Fang d, Chih-Wei Chu b and Lain-Jong Li d

a. Department of Mechanical Engineering, Southern Taiwan University of Science and Technology Tainan, Taiwan
b. Academia Sinica, Research Center of Applied Science, Taipei, Taiwan.
c. Department of Materials Science, King Abdullah University of Science and Technology, Saudi Arabia
d. Material and Chemical Research Laboratories, Industrial Technology Research Institute, Taiwan

*Corresponding author’s e-mail: lunghhu@stust.edu.tw

Elementary sulphur (S) has been shown to be an excellent cathode material in energy storage devices such as Li–S batteries owing to its very high capacity. The major challenges associated with the sulphur cathodes are structural degradation, poor cycling performance and instability of the solid–electrolyte interphase caused by the dissolution of polysulphides during cycling. Tremendous efforts made by others have demonstrated that encapsulation of S materials improves their cycling performance. To make this approach practical for large scale applications, the use of low-cost technology and materials has become a crucial and new focus of S-based Li-ion batteries. Herein, we propose to use a low temperature spraying process to fabricate graphene/S electrode material, where the ink is composed of graphene flakes and the micron-sized S particles prepared by grinding of low-cost S powders.

Low temperature spraying process

The S particles are found to be well hosted by highly conductive graphene flakes and consequently superior cyclability (∼70% capacity retention after 250 cycles), good coulombic efficiency (∼98%) and high capacity (∼1500 mA h g⁻¹). The energy density can achieve 3000 mAhe⁻¹. The proposed approach does not require high temperature annealing or baking; hence, another great advantage is to make flexible Li-ion batteries.

Electrochemical Performance

The flexible battery using commercial LiMn2O4 as the cathode and the sprayed graphene–S (20 : 80) as the anode