Catalytic Effects of Different Loadings of Ni nanoparticles Encapsulated in Few Layers N-doped Graphene and Supported by Ndoped Graphitic Carbon in Li-S batteries

Nurzhan Baikalov[1*], Almagul Mentbayeva[2], Aishuak Konarov[2], Yongguang Zhang[3], Zhumabay Bakenov[1,2**]

[1]*National Laboratory Astana, School of Engineering and Digital Sciences, Nazarbayev University, NurSultan, Kazakhstan*

[2]*School of Engineering and Digital Sciences, Nazarbayev University, Nur-Sultan, Kazakhstan*

[3]*School of Materials Science and Engineering, Hebei University of Technology, Tianjin 300130, China*

*E-mail: nurzhan.baikalov@nu.edu.kz, **E-mail: zbakenov@nu.edu.kz

Lithium-ion batteries (LIB), despite the fact that they have opened up new opportunities for the rapid development of modern portable devices, mainly use intercalation cathodes represented by transition metal oxides and phosphates as cathodes, which are unable to meet the requirements of electric vehicles and high energy storage systems and have several disadvantages associated with the high cost of materials and safety problems. In this regard, Lithium-Sulfur batteries (Li-S) have been considered as promising next generation energy storage systems due to high theoretical energy density (2600 Wh kg-1) with sufficient operating voltage potential of ~2.1 V (vs Li/Li+) alongside its low cost and non-toxicity. Moreover, sulfur has low cost, considerably less environmental impact and abundant resources. However, the implementation of Li-S batteries is hindered due to a number of drawbacks such as low conductivity of sulfur, shuttle of soluble intermediates (polysulfides, LiPS), poor reaction kinetics, dendrite growth on lithium anode and volumetric expansion of cathode upon reduction to Li2S2/Li2S which leads to structural degradation and lower the cycle life of batteries. Several works introduced the application of carbon-based materials decorated with transition metals/electrocatalysts as potential polysulfides trapping systems. However, the use of transition metal nanoparticles is complicated due to lower stability and tendency to aggregation upon cycling. In this regard, it is important to physically separate metal nanoparticles with a uniform distribution and protect them from aggregation and air oxidation. Given that Ni nanoparticles improved reaction kinetics and showed a large potential catalytic effect, it would be worthwhile to comprehensively understand the role of metal loadings in Li-S electrochemistry, which was rarely reported in previous literature. In the present research catalytic effects of Ni nanoparticles encapsulated in N-doped graphene supported by layers of graphitic carbon as electrocatalysts were investigated.

Acknowledgement

This research has been funded by the Science Committee of the Ministry and Science Education of Republic of Kazakhstan (Grant No. AP09259764).