

Expanded Graphite reinforced polystyrene composites for Li-ion battery thermal management

A. R. M. A. M. Rathnayake^{1,2*}, V. G. C. Samanmali^{1,2}, R. T. De Silva², T. Bandara³, M. M. M. G. P. G. Mantilaka³, U. G. D. I. Kariyawasam⁴, J. C. Garusinghe⁴

¹Faculty of Graduate Studies, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka

²CodeGen International (Pvt) Ltd, Bay 1-5, Trace Expert City, Colombo 10, Sri Lanka

³Department of Mechanical Engineering, Faculty of Engineering, University of Sri Jayewardenepura, 41 Lumbini Ave, Dehiwala-Mount Lavinia, Sri Lanka

⁴Vega Innovations (Pvt) Ltd, Bay 1-5, Trace Expert City, Colombo 10, Sri Lanka

Electric vehicles with improved battery pack performance are gaining increasing interest worldwide due to the global challenges of the energy crisis. As a result, compact battery pack designs with high-power densities are being developed and efficient heat removal is crucial for optimal performance. Increased cell operating temperature can lead to reduced efficiency, cell life depletion, and thermal runaway. To achieve optimum performance, one solution is to develop advanced battery modules with new cooling mechanisms, such as heat spreaders, to eliminate heat spots. The present study aims to investigate the effect on Li-ion cell operating temperature, using a composite material consisting of expanded graphite (EG) reinforced polystyrene (PS) as a cell surface cooling aid. EG was prepared by thermal expansion of intercalated natural vein graphite obtained from a Sri Lankan graphite mine at Bogala. Graphite powder was treated with a mixture of concentrated sulfuric and concentrated nitric acid for 24 hours and was then subjected to a thermal shock at 900 °C to prepare expanded graphite. As prepared, EG was then incorporated with dissolved polystyrene in different loadings (50%, 100%, and 200% by weight) to get the composite sheet using the solution casting technique, and the in-plane thermal conductivity of this sheet increased with increasing EG loading. A cylindrical Li-ion cell was covered with composite sheet with thickness 0.5 mm connected to a cooling block and upon charge-discharge cycle at the rate of 2 C, the surface temperature buildup was measured. It was revealed that the composite maintains the cell surface temperature less than 37 °C, a 14% reduction compared to a cell without any heat spreading mechanism in which the surface temperature can rise to a maximum of 43 °C. Therefore, the development of synthesized EG/PS composite sheets opens innovative pathways for enhanced thermal management in Li-ion batteries.

Keywords: Expanded graphite, Heat spreaders, Polystyrene, Thermal management

* ayanthir@codegen.net