Modelling Panel Abstract & Speaker Biography

Development of Safe Rechargeable Li-S Battery Chemistries

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Abstract

Communications-Electronics Research, Development and Engineering Center (CERDEC) is developing wearable power sources for dismounted Soldier applications in the U.S. military. As part of this development, a model has been developed utilizing the U.S. Army Conformal Wearable Battery (CWB) form factor and Li-S cells to determine appropriate safety limits in cell size and configuration. In addition, a study of common Li-S electrolyte systems have been done utilizing accelerating rate calorimetry (ARC), and differential scanning calorimetry (DSC). Finally a novel 1.5 Ah lithium Sulfur (Li-S) pouch cell prototype has been characterized for performance and safety. This work presents the results of the study.

Summary

Conventional Li-ion battery safety incidents have been shown to be related to the flammable electrolytes utilized. The electrolytes are based on alkyl carbonates [1] with lithium salts such as LiPF6, LiBF4, LiB(C2O4)2, and LiBF2C2O4 [2]. In the event of self-heating from a cell short event and subsequent exothermic reactions with active electrode materials, the cell goes into thermal runway [3]. The large temperature rise leads to electrolyte decomposition and gas production. This rapid over-pressurization leads to the venting of the volatile and highly flammable electrolyte, generating an explosive mixture near the cell. Ignition of this mixture leads to damage and rupture of adjacent cells, resulting in cascading battery failure [1] and catastrophic damage.

In the case of Li-S systems, electrolytes such as ethylene glycol-dimethyl ether (DME), 1,3-dioxolane (DOL) and room temperature ionic liquids with LiN(SO2CF3) and LiNO3 have been utilized [4,5]. In addition, it has been reported [6] that, as a result of the reactive nature of the polysulfides, self-heating of fully charged Li-S systems can occur as low as 50 ºC. For comparison, a 1.35 Ah LiCoO2 18650 format cell shows an onset of thermal run way at 104 ºC [7].

To develop a high performance Li-S system with acceptable safety the authors have developed a thermal model of the U.S. Army CWB form factor using experimental and literature results of Li-S electrolytes and pouch cells. The model is useful to predict thermal characteristics, including maximum temperature of the battery to avoid thermal runway during operation. The results of the study will be presented.

References

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Speaker Biography:

Dr. Clifford Cook received his Ph.D. in chemistry at The George Washington University in 2011. He is currently a research chemical engineer at the US Army CERDEC CP&I Power Division. He has made significant contributions to the development of man portable multi-fueled generators, Li-air battery systems, and is currently the principal investigator for Li-S battery systems. He has worked on program management, research, development and fielding of tactical power sources.