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# Li Ion Battery Pack Reliability Assurance

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The advancement of Li Ion battery has enabled many applications that can help to reduce carbon loading, such as electrified transportation, electrical energy storages from renewable energy sources etc. In most of these applications, many Li Ion battery cells are interconnected to form battery pack, the reliability and lifespan of these packs are crucial as they tend to be expensive and the failure of any cell within the pack can endanger the entire pack and even the engineering system that it is powering on. A conservative approach to ensure safe operation of the pack is to replace the pack pre-maturely, increasing the cost of the engineering systems powered by the Li Ion batteries.

To ensure reliable battery pack with long life, several approaches can be adopted. One is to choose reliable cells; another is to have redundant cells; still other is to ensure good cells balancing through the battery management system; and the last approach which is seldom addressed is to ensure the reliability of interconnections between cells. However, there are many challenges in these approaches to assure pack reliability, namely accurate determination of the health of each cell; computation of pack reliability from cells' health index; optimal number of redundant cells for cost consideration and determination/prediction of interconnections reliability and lifetime.

In this talk, electrochemistry based electrical (ECBE) model, an accurate, non-destructive and in-situ determination of the state of health (SoH) of each cell in a pack will be presented. The incorporation of these SoH information from all these cells to compute a pack reliability will be demonstrated, and the method to determine optimal number of redundant cells for given cells' SOH will also be explained. The reliability of different type of interconnections used in the construction of battery pack will also be introduced. Future research needed to ensure battery pack reliability will also be discussed.

**Keywords**: State of health; battery pack reliability; optimal cell redundancy scheme; cells interconnection reliability; ECBE

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# 锂电池组可靠性保证

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锂电池的进步推动了许多应用，可以帮助减少碳排量，如电气化运输，自可再生能源的电能量存储器等。在大多数这些应用中，许多锂离子电池单元互连以形成电池组。这些电池组的可靠性和寿命是非常重要的因为它们的成本是昂贵的，在组内的任何单元的故障可以危及整个电池组，甚至危机到整个供电的工程系统。保守的方法是在电池组未完全损坏的前提下取代整个电池组，以确保电池组的安全运行，但这样大大地提高了以锂电池为能源的工程系统的成本。

为确保可靠的电池组并拥有长寿命，几种方法可以采用。一是要选择可靠的电池; 另一种是有备用的电池; 还有另一种是，通过电池管理系统确保好的电池个体间的平衡性；最后一种很少采用的方法是确保电池之间的互相连接的可靠性。但是，这些方法面临许多挑战，即准确地确定每个电池单体的健康状况; 从电池的健康指数计算电池组的可靠性；冗余单元成本的考虑和制定/预测互连的可靠性和寿命。

在这次讲座中，基于电化学电学（ ECBE ）模型， 我会讲述准确，无损坏和即时现场测定电池组中电池个体的健康状态的方法。从所有这些电池个体的健康状态的信息来计算电池组可靠性的方法也会被展示，并且通过该方法去确定冗余单元的最佳数目将会被进一步解释。不同类型的电池组连接方法的可靠性将会介绍。确保电池组的可靠性的未来的研究也会在这里讨论。

**关键词：**健康状态；电池组可靠性；最佳电池个体冗余方案；电池链接可靠性；ECBE