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Mechanical Properties of Lithium-Ion Battery at Different Packing Angles Under Impact Loading

Authors : Wei Zhao, Yuxuan Yao, Hao Chen

Abstract : In order to find out the mechanical properties and failure behavior of lithium-ion batteries, drop hammer impact experiments and finite element simulations are carried out on batteries with different packed angles. Firstly, a drop hammer impact experiment system, which is based on the DHR-1808 drop hammer and oscilloscope, is established, and then a drop test of individual batteries and packed angles of 180 ° and 120 ° are carried out. The image of battery deformation, force-time curve and voltage-time curve are recorded. Secondly, finite element models of individual batteries and two packed angles are established, and the results of the test and simulation are compared. Finally, the mechanical characteristics and failure behavior of lithium-ion battery modules with the packed arrangement of 6 * 6 and packing angles of 180 °, 120 °, 90 ° and 60 ° are analyzed under the same velocity with different battery packing angles, and the same impact energy with different impact velocity and different packing angles. The result shows that the individual battery is destroyed completely in the drop hammer impact test with an initial impact velocity of 3m/s and drop height of 459mm, and the voltage drops to close to 0V when the test ends. The voltage drops to 12V when packed angle of 180°, and 3.6V when packed angle of 120°. It is found that the trend of the force-time curve between simulation and experiment is generally consistent. The difference in maximum peak value is 3.9kN for a packing angle of 180° and 1.3kN for a packing angle of 120°. Under the same impact velocity and impact energy, the strain rate of the battery module with a packing angle of 180° is the lowest, and the maximum stress can reach 26.7MPa with no battery short-circuited. The research under our experiment and simulation shows that the lithium-ion battery module with a packing angle of 180 ° is the least likely to be damaged, which can sustain the maximum stress under the same impact load.

Keywords : battery module, finite element simulation, power battery, packing angle
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