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Crashworthiness and Structural Durability of Lithium-Ion Battery Packs under Impact and Drop Scenarios

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Abstract: *The Increase of use of LIB systems in vehicles, electric operated consumer electronic products, and energy storage, the mechanical and crashworthiness of such systems is of considerable concern. This research focuses on the crashworthiness and structural integrity of Lithium-ion battery pack in different impact and drop tests in order to mimic real-world conditions such as vehicle crashes, falls, and mechanical treatments of batteries. The finite element analysis (FEA) is done at cell, module, and pack levels and adopted explicit dynamic solvers to determine the stress distribution, deformation patterns, and potential failure modes. The work takes into account different restrictions and velocities of the aircraft, as well as the sides at which it impacts: side, bottom, and corners. Casing structures, areas prone to the thermal runaway, and internal battery components are incorporated within the simulation the mechanical behavior and safety-related results. The experimental verification is performed to drop test and crash impact test with commercial 18650 and pouch cell based battery modules. These aspects involve peak acceleration, energy absorption capability, intrusion depth, and structural aspects aiming at identifying the ability of the structure to withstand an impact. The observations from the current development offer means of further future alterations in designing the protective structure for battery enclosure to reduce potentials of electric shock or heat build-up during mechanical stress. They contribute to the understanding of the safety requirements that should be incorporated in futuristic lithium-ion batteries as well as addressing how lithium-ion batteries can be made to be safe, especially for use in mobility and storage facilities.*

Keywords: Lithium ion battery, Electric vehicle, drop and impact test, crashworthiness, finite element analysis.