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Simulation of an electric vehicle (EV) crash using a homogeneous Finite Element (FE) model of a battery pack

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The primary aim of this study is to evaluate the computational feasibility of multi-scale battery models in automotive safety simulations. Specifically, the research seeks to interpret the structural response of a full-scale battery pack through the lens of individual cell-level deformation to predict potential failure points.

The researchers developed a comprehensive battery pack model by upscaling previously validated, homogeneous cell-level models. This assembly was integrated into a modified 2012 Toyota Camry chassis and subjected to rigorous crashworthiness simulations, including frontal and side pole impacts, following Euro NCAP protocols. The analysis focused on identifying localised strain within the pack that could lead to internal short circuits (ISC) and subsequent thermal runaway (TR).

The simulations demonstrate that side pole impacts result in significantly more severe battery deformation compared to frontal crashes. However, at standard regulatory testing velocities, the observed cell-level deformations remained below the critical thresholds established in previous experimental trials.

The findings suggest that while current standard testing speeds may not trigger catastrophic battery failure, the risk of internal short circuits increases substantially at higher impact velocities or with smaller pole diameters. The study confirms that multi-scale modelling is a viable tool for identifying vulnerable regions within a battery pack during the design phase.

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