Numerical simulation of dynamic response of a composite battery housing for transport applications

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Abstract

With the electrification of Europe's fleet of aircraft and vehicles, the demand for high-performance batteries with increased environmental sustainability has become crucial. Among the components, the housing stands out as the most structurally critical. High-performance and sustainable batteries necessitate lightweight, thermomechanically robust, and recyclable housings. In this context, thermoplastic housings exhibit promising advantages due to the advantages of the thermoplastics against metals and thermoset composites. This study focuses on simulating the dynamic response of a novel battery housing constructed from an innovative thermoplastic composite material using the FE method implemented in the LS-Dyna software. The thermoplastic composite comprises a hybrid matrix (ELIUM MC and Martinal ATH) reinforced by glass fibers. Initial mechanical properties of the composite are characterized through standardized mechanical tests. The housing undergoes analysis under various loading scenarios, including sine-sweep and random vibration, mechanical shock, and impact loads. Throughout these analyses, the housing's structural integrity is thoroughly assessed for potential failures. Numerical results demonstrate that the housing remains resilient against vibration and mechanical shock. Additionally, while low-energy impact induces some damage, it does not impede the battery pack's normal operation. However, high-energy causes substantial damage that compromises the integrity of the battery. Importantly, the FE model of the battery housing serves as a basis for the creation of a digital twin of the battery, offering opportunities for further design and optimization strategies.

Acknowledgement:

This abstract is presented in accordance with the research program "TEMPEST".

HORIZON-CL5-2022-D2-01-05 — Next generation technologies for High-performance and safe-by-design battery systems for transport and mobile applications (Batteries Partnership).