World Academy of Science, Engineering and Technology
International Journal of Transport and Vehicle Engineering
Vol:15, No:08, 2021

Thermoplastic-Intensive Battery Trays for Optimum Electric Vehicle Battery Pack Performance

Authors : Dinesh Munjurulimana, Anil Tiwari, Tingwen Li, Carlos Pereira, Sreekanth Pannala, John Waters

Abstract : With the rapid transition to electric vehicles (EVs) across the globe, car manufacturers are in need of integrated and lightweight solutions for the battery packs of these vehicles. An integral part of a battery pack is the battery tray, which constitutes a significant portion of the pack's overall weight. Based on the functional requirements, cost targets, and packaging space available, a range of materials –from metals, composites, and plastics– are often used to develop these battery trays. This paper considers the design and development of integrated thermoplastic-intensive battery trays, using the available packaging space from a representative EV battery pack. Presented as a proposed alternative are multiple concepts to integrate several connected systems such as cooling plates and underbody impact protection parts of a multi-piece incumbent battery pack. The resulting digital prototype was evaluated for several mechanical performance measures such as mechanical shock, drop, crush resistance, modal analysis, and torsional stiffness. The performance of this alternative design is then compared with the incumbent solution. In addition, insights are gleaned into how these novel approaches can be optimized to meet or exceed the performance of incumbent designs. Preliminary manufacturing feasibility of the optimal solution using injection molding and other commonly used manufacturing methods for thermoplastics is briefly explained. Then numerical and analytical evaluations are performed to show a representative Pareto front of cost vs. volume of the production parts. The proposed solution is observed to offer weight savings of up to 40% on a component level and part elimination of up to two systems in the battery pack of a typical battery EV while offering the potential to meet the required performance measures highlighted above. These conceptual solutions are also observed to potentially offer secondary benefits such as improved thermal and electrical isolations and be able to achieve complex geometrical features, thus demonstrating the ability to use the complete packaging space available in the vehicle platform considered. The detailed study presented in this paper serves as a valuable reference for researches across the globe working on the development of EV battery packs – especially those with an interest in the potential of employing alternate solutions as part of a mixed-material system to help capture untapped opportunities to optimize performance and meet critical application requirements.

Keywords : thermoplastics, lightweighting, part integration, electric vehicle battery packs
Conference Title : ICEV 2021 : International Conference on Electric Vehicles
Conference Location : New York, United States
Conference Dates : August 09-10, 2021