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GAGE OPTIMIZATION AND WEIGHT REDUCTION IN AUTOMOTIVE CLOSURES

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ABSTRACT

Automotive closures, such as doors, hoods, and trunks, are of great importance to vehicle performance, safety, and fuel efficiency. Weight reduction in these components has become one of the critical focuses in the automotive industry since it directly impacts overall vehicle efficiency, sustainability, and regulatory compliance. Over the last decade (2015-2024), a number of studies have worked out innovative strategies for weight reduction and gage optimization in automotive closures. These strategies mainly focus on the optimization of material selection, structural design, and manufacturing processes to reach a balance in reducing weight while keeping the necessary strength and crashworthiness. Advanced materials, such as aluminum alloys, high-strength steels (AHSS), and composites like carbon fiber-reinforced plastics (CFRP), have been widely used, leading to significant weight savings ranging from 20% to 40%. Meanwhile, gage optimization techniques, including finite element analysis (FEA) and topology optimization, have proven effective in redistributing material while preserving structural integrity. Multi-material assemblies and hybrid designs combining aluminum, steel, and composites have also been pursued to achieve the best balance of weight and performance. Further, advanced manufacturing techniques, such as additive manufacturing, hydroforming, and advanced stamping processes, have further enabled the reduction of weight by allowing complex geometries to be created and more efficient use of materials. Challenges still exist in terms of cost, manufacturing complexity, and ensuring the crashworthiness of lightweight closures. Moving forward, further research into hybrid materials, manufacturing techniques, and computational optimization methods will likely drive the next wave of innovations in automotive closure design.

KEYWORDS: *Automotive closures, weight reduction, gage optimization, advanced materials, high-strength steel, aluminum alloys, composites, carbon fiber-reinforced plastics, topology optimization, finite element analysis, multi-material assemblies, hybrid materials, additive manufacturing, hydroforming, crashworthiness, manufacturing techniques, structural integrity.*

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