Aluminum expected to accelerate worldwide adoption of electric and self-driving vehicles

Material takes on an ever-widening role in tomorrow's vehicles

For more than a decade, concerns about fuel efficiency have been encouraging OEMS to replace steel with aluminum on vehicle bodies, doors, trunks, hoods, bumpers, crash boxes, brakes, cables and wheels. With the advent of electric and autonomous vehicles, OEMs worldwide are discovering new uses for aluminum.

The need for battery casings and heat exchangers in electric vehicles, combined with autonomous vehicles' demands for high visibility and structural integrity, is expected to exponentially increase the use of sheet aluminum in tomorrow's cars, trucks and buses.

Supporting the transition to battery-powered vehicles

Four major design challenges confront OEMs in their transition to electric vehicles.

- Extending vehicle range
- Improving battery and passenger safety
- Increasing passenger comfort
- Optimizing cooling systems for lithium-ion batteries

The substitution of sheet aluminum for steel helps resolve OEM concerns.

Extending range

The lighter the vehicle, the longer its range. According to Ducker Worldwide, aluminum is expected to contribute more than half of the anticipated vehicle mass reduction demanded by electric vehicles (EVs) to extend range. Ducker reports that in North America alone, aluminum content in EVs will increase to nearly 565 pounds (256 kilgrams) per vehicle by 2028.

The larger the vehicle, the heavier the battery and casing required to optimize the EV's range. It is the larger EVs, i.e., sedans, SUVs, taxis, trucks and buses, that will realize the greatest benefits from a steel-to-aluminum conversion. In the U.S., a vehicle's gross weight determines which class of commercial driver's license (CDL) will be required. Without lightweighting, some EVs could demand a higher-class license or additional endorsements due to the added weight of the battery. In older European cities like Brussels or London, some bridges and tunnels only allow vehicles up to 3.5 tons in weight, a target that is very difficult to meet for larger EVs without lightweighting.

For heavier material transport EVs such as trucks, weight reduction enables an increased payload, providing a significant monetary benefit. Generally, the larger the vehicle, the higher the payback.

Particularly relevant for larger human transport EVs such as buses and taxis, the weight reduction made possible through aluminum provides the added benefit of reduced CO_2 emissions and improved air quality, of value not only to vehicle operators, but to the communities they serve.

Optimizing battery and human safety

The thermal and anti-corrosion properties of aluminum make it ideal for battery frames. Sea-water resistant, highly formable, highly surfaced aluminum alloys provide the strength necessary to pass side-impact crashworthiness testing, protecting passengers and the battery should impact occur. Casing floor plates made out of aluminum are not only strong, but also capable of resisting corrosion related to weather exposure. These characteristics enable aluminum battery casings to resist weather-related deterioration and impact from road debris, minimizing the risk of related fires and further securing passenger safety.

Dispersing heat

The batteries used in EVs produce energy while charging and decharging, requiring the use of heat exchangers to dissipate heat. But the types of heat exchangers used in vehicle air conditioning systems are inadequate to meet this new challenge.

Aluminum clad brazing (which connects multiple layers of aluminum together to disperse heat) requires heating in a controlled atmosphere (e.g., a vacuum) to achieve optimum joining. Aluminum heat exchangers designed specifically to meet the challenges presented by electric vehicles can use as many as five types of aluminum sandwiched together, with the layers providing gradient properties to optimize cooling.

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These specialized processes and materials address OEM concerns, ensuring adequate dissipation of the heat generated by battery-powered vehicles. An experienced aluminum processing partner can help OEMs specify the right process and alloys to meet specific vehicle temperature thresholds, ideally working side by side with OEM engineers early in the design process to maximize the performance of electric vehicles.

Supporting the eventual transition to autonomous vehicles

The luxury sedan market will likely be the first to transition to self-driving electric vehicles. Passenger comfort and safety, and an expansive view of the surrounding environment, are expected to be top priorities for this market. The hefty B pillars used in conventional vehicles to meet structural requirements for crashworthiness are undesirable in a self-driving scenario. To enable large windows and an unobstructed view without sacrificing passenger safety, lightweight aluminum will be the strong material of choice.

Ongoing environmental concerns

In addition to the design challenges presented by EVs, society's demand for sustainable solutions will likely continue to be a driver in the transition to aluminum-lightweighted vehicles. A Forschungsgesellschaft Kraftfahrwesen mbH Aachen (fka) study, using a Volkswagen Golf as its reference vehicle, determined that an electric aluminum-based vehicle could meet the same safety standards as its steel-based equivalent, while emitting 1.5 tons less greenhouse gases over its lifecycle, taking into consideration production, a total driving distance of more than 93,000 miles (150,000 kilometers) and eventual recycling.

Conclusion

Aluminum alloys are ideally suited to the design challenges presented by electric and autonomous vehicles. By aligning with aluminum partners deeply experienced in developing processes and alloys to meet demanding performance requirements, transportation vehicle OEMs are accelerating the pace of EV and self-driving vehicle adoption throughout North America. •

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